

Predesign Technical Summary

Contract No. DACW 41-90-D-0009

**Remedial Design
Former Nebraska Ordnance Plant
Operable Unit 1
Mead, Nebraska**

Prepared for:



U.S. Army
Corps of Engineers

Department of the Army
U.S. Army Engineer District
Kansas City Corps of Engineers
Kansas City, Missouri

June 21, 1994

RUST ENVIRONMENT &
INFRASTRUCTURE



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PREDESIGN TECHNICAL SUMMARY

**Remedial Design
Former Nebraska Ordnance Plant
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Prepared for:

**U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, Missouri 64106**

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RUST E&I Project No. 72736

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1.0 INTRODUCTION

This Predesign Technical Summary for Operable Unit (OU) 1 of the former Nebraska Ordnance Plant (NOP) site near Mead, Nebraska, has been prepared by RUST Environment & Infrastructure (RUST) under Contract No. DACW-41-90-D-0009 for the U.S. Army Corps of Engineers (USACE), Kansas City District. A Remedial Investigation/Feasibility Study (RI/FS) was conducted for OU 1 under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which was amended by the Superfund Amendments and Reauthorization Act (SARA). The governing regulations for CERCLA are the National Contingency Plan (NCP), 40 CFR Part 300.

Operable Unit 1 addresses direct contact of explosives-contaminated soil at the site. A Feasibility Study is currently being performed for Operable Unit 2, which addresses groundwater contamination and explosives-contaminated soil which could act as a source of groundwater contamination. Operable Unit 3, which addresses on-site waste disposal areas and other issues not included in the other two Operable Units, is undergoing Remedial Investigation.

Based on the RI/FS, a proposed remedial action has been selected for OU 1. Final remedy selection will be made following the public participation period. Due to a statutory constraint that limits the time between the selection of the final remedy and the start of the remedial action, this document initiates the remedial design based on the assumption that the proposed remedy will be selected as final. As such, the language used in this document presumes that the proposed remedy has been selected. If the proposed remedy is not selected as final, this document will be reissued based on the new remedy.

This Predesign Technical Summary discusses issues relevant to the design of the remedial action for OU 1 at the NOP site. The purpose of the Predesign Technical Summary is to:

- Provide all parties involved in the design (designer, reviewer, contractor, regulator) with a clear understanding of the technical objectives of the remedial action,
- Summarize available information upon which the remedial design will be developed, and
- Identify outstanding issues to be addressed during the remedial design process.

2.0 SITE CONDITIONS

2.1 SITE DESCRIPTION

The former Nebraska Ordnance Plant (NOP) site consists of 17,258 acres, located approximately 1/2-mile south of the town of Mead, Nebraska (Figure 1). Approximately 10,000 acres of the site are currently owned by the University of Nebraska, and are used as an agricultural research station. Approximately 2,000 acres are owned by the National Guard and Army Reserves, and the remainder is owned by private individuals. Uses of this private land include farming and some light industry. The site is easily accessible from State Highway 92 and local roads.

2.1.1 Site History and Current Status

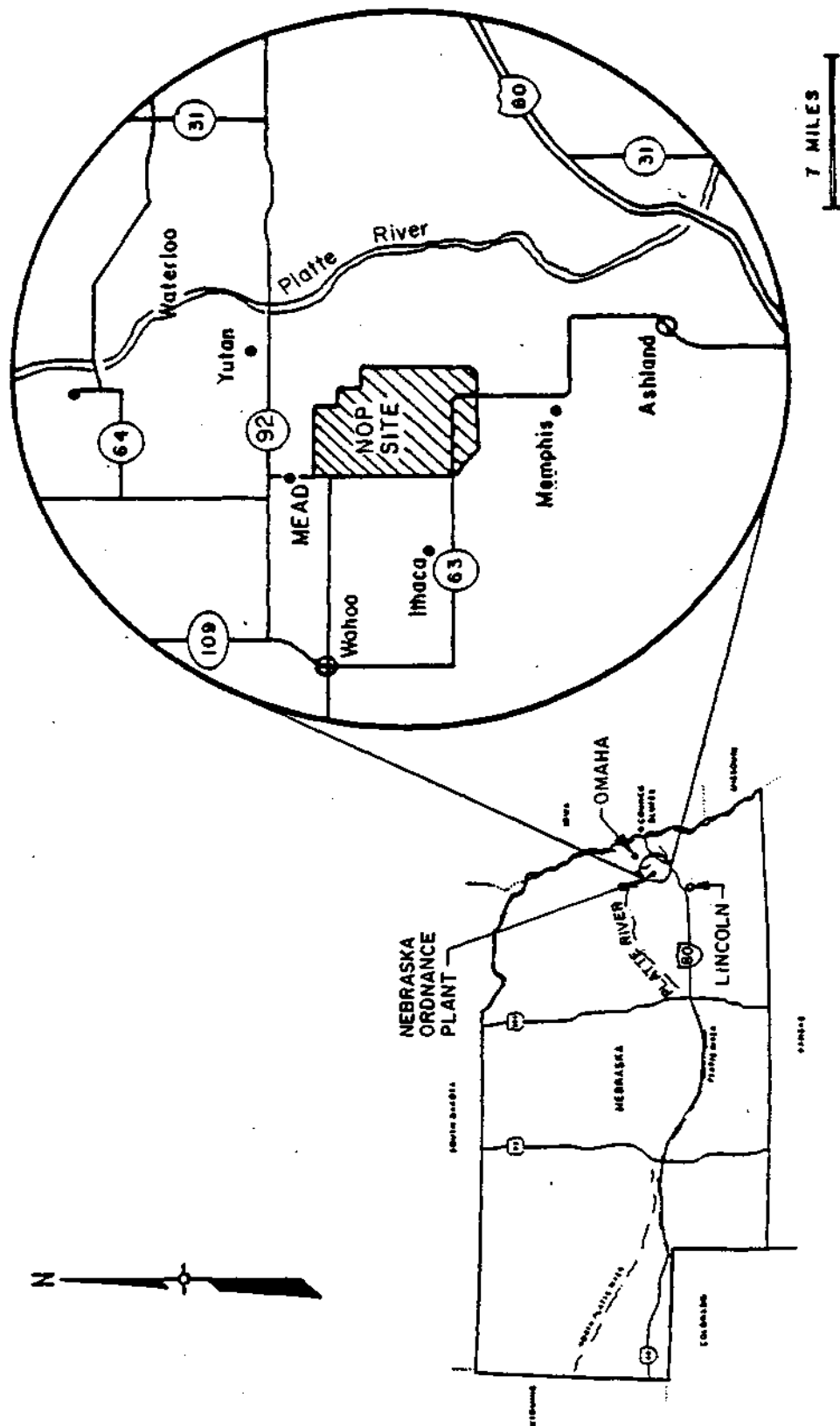
The NOP was a load, assemble, and pack facility which produced bombs, boosters, and shells. Production facilities were active during World War II and the Korean Conflict. These facilities included:

- Four bomb load lines.
- A bomb booster assembly plant.
- An ammonium nitrate plant.
- A burning/proving ground.
- A wastewater treatment plant.
- Analytical laboratories.
- An administration area.

The site layout is shown in Figure 2. Much of the land where the facilities operated is now owned by the University and includes buildings with implement storage, crop land, plant test plots, pastures, animal pens, and fallow land. A small portion of the land which is owned by private individuals is crop or fallow land. Numerous buildings exist on-site; some have been improved for University or private use, and others have fallen into disrepair. On-site buildings and current activities may restrict locations of remedial action facilities, and permission of the University or other current landowners may be required.

The climate of eastern Nebraska is generally continental, with warm summers, and cold, dry winters. Average annual precipitation is 28 inches, with the majority of that occurring as showers and thunderstorms from April through September.

The NOP Community Relations Plan (SEC Donohue, 1992a) contains additional information on the current status of the site and surroundings and a list of local and government personnel (Technical Review Committee) who can provide additional information on the current status of the site.



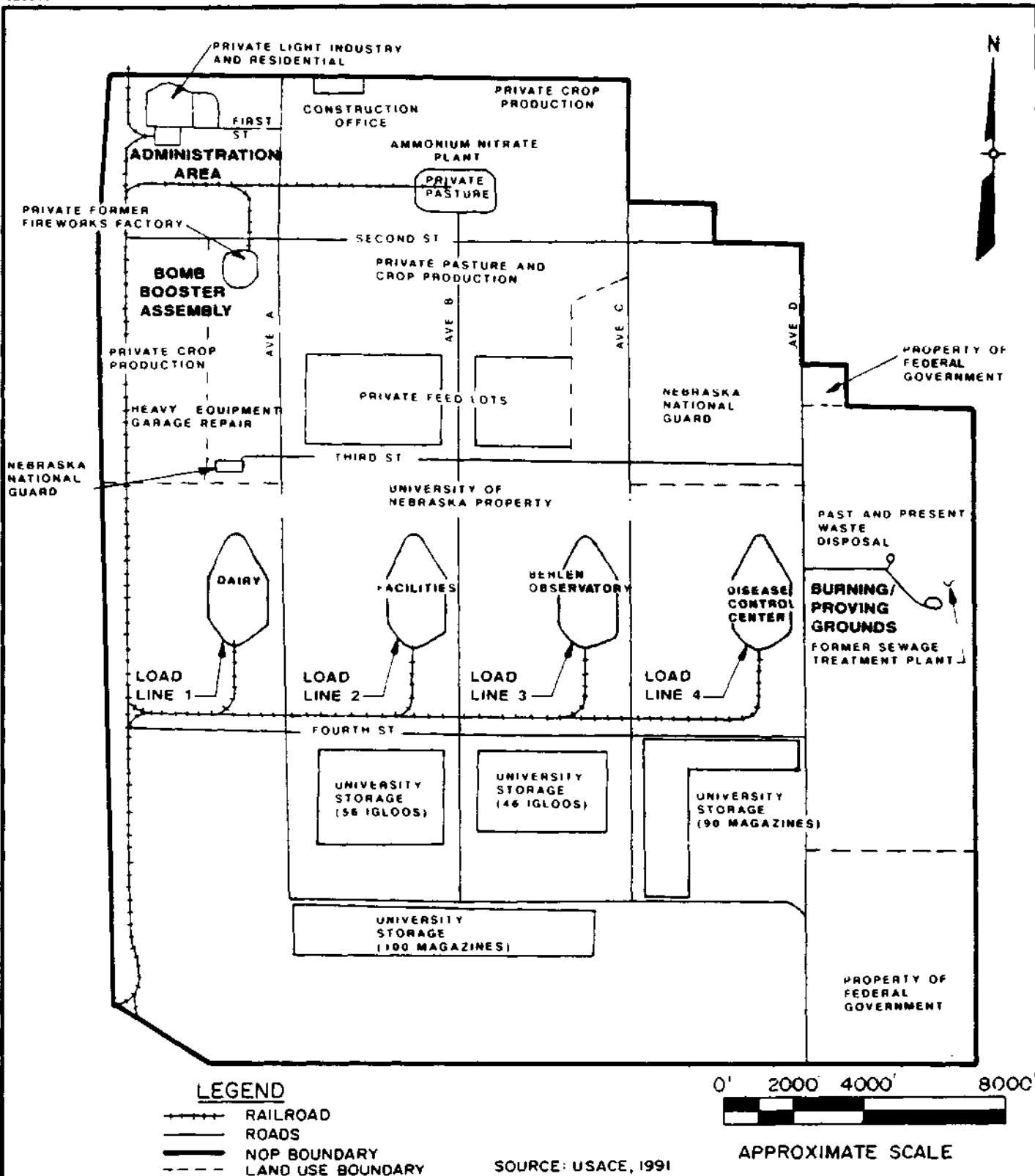
SOURCE: TCT, 1991

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FIGURE 1
SITE LOCATION MAP
 PREDESIGN TECHNICAL SUMMARY
 FORMER NEBRASKA ORDNANCE PLANT
 MEAD, NEBRASKA

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2.1.2 Physical, Geological, and Chemical Characteristics of the Site

The site is generally flat, with only minor changes in topography. Surface elevations range from 1,105 feet MSL to 1,180 feet MSL. Surface soils predominantly consist of silty clay loams of the Butler, Sharpsburg, Fillmore, Ortello, and Colo series. In some areas, surface soils derive from sandy alluvium, rather than silty clay loess. Subsurface soils include, from youngest to oldest, Peoria Loess, Todd Valley Sand, and Grand Island-Crete Sand and Gravel. Bedrock in the area consists of the Huntsman Shale and the Cruise Sandstone, and lies approximately 70 to 170 feet below the surface. The Huntsman Shale overlies the Cruise Sandstone and is discontinuous in the area of the NOP site.

Groundwater is the primary source of water used in the area. Most of the groundwater extracted is from the Pleistocene sand and gravel aquifer. This unconfined system is in hydraulic connection with the underlying sandstone aquifer where the shale is not present to act as an aquitard. Groundwater flow is generally to the south-southeast. Since this is a water table aquifer, the depth to water varies with recent local rainfall. At the time of the OU 1 Remedial Investigation, groundwater was encountered at a depth of approximately 40 feet below the ground surface.

Because the site is rather flat, surface water drainage was supplemented by man-made ditches. Surface water from Load Line 1 and the Administration Area flows generally south toward Silver Creek. Surface water at the rest of the site flows south and east to Johnson Creek and Clear Creek. In the east of the site, near the Burning/Proving Grounds, Johnson Creek was dammed to create the Natural Resources District (NRD) Impoundment.

Vegetation on the site is consistent with current uses, and is mainly comprised of various areas of crops (such as corn) and turf grasses. There are also several small stands of trees on site, mostly hardwoods.

Explosives compounds, breakdown products, and impurities associated with explosives production which have been detected in soil at the site include:

- 2,4,6-Trinitrotoluene (TNT).
- Hexahydro-1,3,5-trinitro-1,3,5-triazine (royal demolition explosive or RDX).
- 1,3-Dinitrobenzene (DNB).
- 2,4- and 2,6-Dinitrotoluenes (DNT).
- 1,3,5-Trinitrobenzene (TNB).
- Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (high melt explosive or HMX).
- n-2,4,6-Tetranitro-n-methylaniline (tetryl).
- o-, m-, and p-Nitrotoluene (NT).

The compounds were detected in all four of the load lines, the Bomb Booster Assembly Area, and the Burning/Proving Grounds. The compounds most often detected in soil sampled in OU 1 were TNT, TNB, and RDX. Contamination is most often associated with drainage ditches and

sumps in the load lines. Explosives contamination in areas outside the ditches and sumps occurs in localized areas. In the load lines, contamination is believed to have originated from discharge of wash water from the ordnance manufacturing process. In the Bomb Booster Assembly Area, activities associated with the manufacture of boosters probably caused contamination. In the Burning/Proving Grounds, testing and burning activities are believed to have caused contamination of soil. No significant explosives contamination has been found in either the Primary Area (the area surrounding the load lines) or the Administration Area. Most of the contaminated soil is found within 5 feet of the soil surface, but the maximum depth of contamination measured and detected in the investigations at the site is approximately 30 feet.

2.1.3 Surrounding Land Use

The University of Nebraska and other landowners in the area also use private wells for agricultural purposes, such as irrigation. There are private homes in the area where groundwater is used for domestic purposes (drinking and washing). The nearest schools are in the Town of Mead, and are located approximately 3 miles north of the contaminated areas of the site. Some of the homes are within 1 mile of areas of contaminated soil.

Most of the surrounding land use is agricultural. However, there are some light industrial activities in the former Administration Area, and the Town of Mead is nearby. The Town of Mead uses groundwater for its municipal water supply, but its well field is north (upgradient) of the NOP site.

There are no known plans for changes in land use at the site. As the majority of the land is owned by the University of Nebraska and the United States government, it may be expected that land ownership will remain stable. Some plans have been made to make improvements on University property, but the mission of the agricultural research station is not expected to change. Property boundaries on drawings used in the RI/FS are taken from plat maps and other existing drawings.

2.2 REAL ESTATE AND UTILITIES

Because the site is used for agricultural purposes, there are not expected to be significant restrictions which may be imposed on remediation activities. University personnel have, however, expressed a preference that remediation activities be conducted within one of the "diamond areas" of Load Line 1 or 2. These diamond areas contain an area of approximately 5-1/2 acres each. Based on the equipment, buildings, and space requirements estimated in the FS, additional space will be required. Additional space arrangements will be negotiated with the University, as space requirements are further defined based on detail of the design.

There are no known restrictions for vehicle traffic on existing State and local roads. On-site vehicle routes will be developed during the design based on coordination with the University.

There are some existing utilities on-site. The University of Nebraska, on-site industrial facilities and residences are tied into the local power grid. Natural gas is available at the site but coordination with the University and local public service will be required to meet the needs of the remedial action. The University of Nebraska has limited water supply (particularly during irrigation). An additional off-site water source may be required. The University is providing drawings showing existing utilities to be used in the design.

3.0 SELECTED REMEDY

3.1 DESCRIPTION OF THE REMEDY

The selected remedy for OU 1 at the former NOP site includes on-site rotary kiln incineration of explosives-contaminated soil. The primary components of the selected remedy include:

- Excavation of contaminated soil from source areas and confirmation sampling to show that the lateral extent of contamination has been excavated.
- Hauling excavated soil to a staging/stockpile area.
- Pretreatment (such as size reduction of soil clumps) necessary for treatment.
- Rotary kiln incineration of soil with appropriate emission controls.
- Sampling and analysis of treatment residuals to confirm treatment effectiveness.
- Blending treated soil with clean soil, as necessary, to sustain vegetation.
- Backfilling treated soil to source areas and revegetation.

It is expected that the soil stockpile will be kept covered to minimize fugitive dust emissions, rainwater runoff to surface water, and infiltration to groundwater. Pretreatment is anticipated to be completed in a temporary building for similar reasons.

3.2 REMEDIATION GOALS

Remediation Goals (RGs) were established during the Feasibility Study (FS) process. These RGs are based on risks due to incidental ingestion of soil. RGs are the concentrations of compounds of concern that define the soil to be excavated and treated. These RGs are also the standards by which treatment of these compounds will be evaluated. RGs for the chemicals of concern in OU 1 soil are shown in Table 1.

RGs will be applied to a maximum depth of 4 feet because that is the depth of soil below which a person is unlikely to come into direct contact with contaminated soil based on site use and characteristics (USEPA, 1993). Therefore, the excavation is assumed to be to a depth of 4 feet, and confirmation samples are not anticipated to be required in the bottom of the excavation.

TABLE 1
REMEDIATION GOALS

Compound	RG(mg/kg)
HMX	1715.2
RDX	5.8
TNB	1.7
DNB	3.4
TNT	17.2
DNT	0.9
NT	343.0
Tetryl	343.0

4.0 AVAILABILITY OF DATA

Physical and chemical data regarding site soil contaminated with explosives compounds based on investigations to date are available in the Supplemental Remedial Investigation Report (SEC Donohue, 1992b), in addition to the USACE Remedial Investigation (USACE, 1991), and the Confirmation Study (USACE, 1989). These documents are available in the Former NOP Site Operable Unit 1 Administrative record (Ashland Library in Mead, Nebraska) or the RUST project file. Soil chemical data collected during these investigations are available in a RUST database.

Bench-scale treatability studies were conducted for rotary kiln incineration. Treatability study data is available in the Draft Treatability Study Report (RUST, 1993). Pretreatment and post-treatment soil chemical data from the Treatability Study are also available in the RUST database.

Site background data are summarized in the documents referenced above and other documents located in the administrative record. Community relations information and activities are discussed in the Community Relations Plan (SEC Donohue, 1992a). Historical air photos, maps of the site, and a video recorded during a site visit, are available as part of the RUST project file. The video (taken in the spring of 1992) provides information regarding the site layout topography, vegetation, access, and buildings.

As discussed in Section 2, the University can provide additional information on existing site utilities, current land use, and past University activities which may affect the remedial design.

5.0 REMEDIATION APPROACH

This section summarizes the material to be remediated and the components that will make up the remediation scheme.

5.1 WASTE CHARACTERIZATION

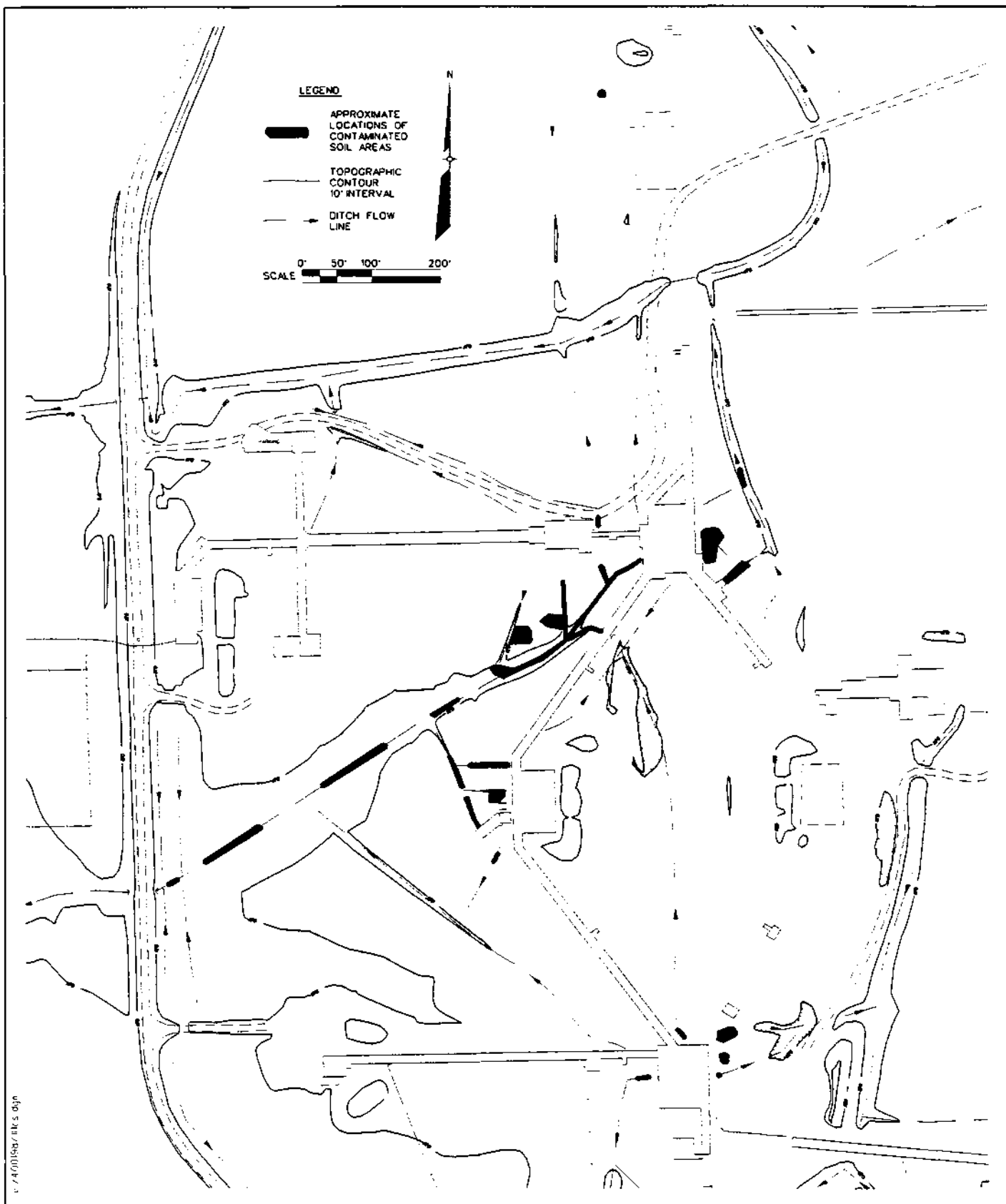
Figures 3 through 8 show the spatial distribution of soil to be excavated and treated. Depth of excavation will be 4 feet in all of the areas shown in the figures. The areas and volumes of soil to be remediated were estimated for the FS, based on RGs shown in Table 1 and sampling conducted to date. The estimated area and volume of soil are given in Table 2. A predesign investigation will be conducted to further evaluate and confirm these excavation areas. Appendix A describes the predesign investigation sampling strategy. The final extent of excavation for treatment will be determined by confirmation sampling.

Most of the material is expected to consist of soil, although some buried debris may be present in areas to be excavated. This debris may consist of concrete and steel sumps, clay piping, or other materials. The quantity of buried debris in source areas is not known, but is expected to be minimal based on historical activities of the site. For the purpose of the FS evaluation, an estimate of 10 percent of the total volume was assumed to be debris.

Physical data for the dominant soil type to be treated is given in Table 3. This type of soil is found throughout most of the site. There may be some areas of contaminated soil near the creek which do not consist of clay and silt, but of sandy alluvium.

Concentrations of compounds of concern are not uniform throughout source areas, but vary from nondetect up to approximately 170,000 mg/kg. Based on DOD studies (USATHAMA, 1987), explosives concentrations above 100,000 mg/kg (10 percent) can be reactive. Two samples (one near the west side of the Load Line 1 diamond area, and one to the northwest of the Load Line 2 diamond area) out of approximately 1,400 from the site had concentrations above 10 percent. A removal action which includes fencing the two areas is being conducted. It is not expected that additional locations having potentially reactive concentrations of explosives will be encountered. However, the excavation and consolidation plan must account for the two locations identified and the possibility of additional locations.

There may be soil at depths greater than 4 feet in OU 1 which may act as a source of explosives contaminants to groundwater. The explosives compound concentrations and volume of soil which will be remediated are being evaluated as part of the OU 2 FS. Following the determination of soil volume under OU 2 and the evaluation of remediation alternatives for that soil, it may be added to the quantity to be incinerated under OU 1. This determination will be made during the OU 1 design process and will affect estimates of quantity, duration, and cost and could affect the incinerator system design.

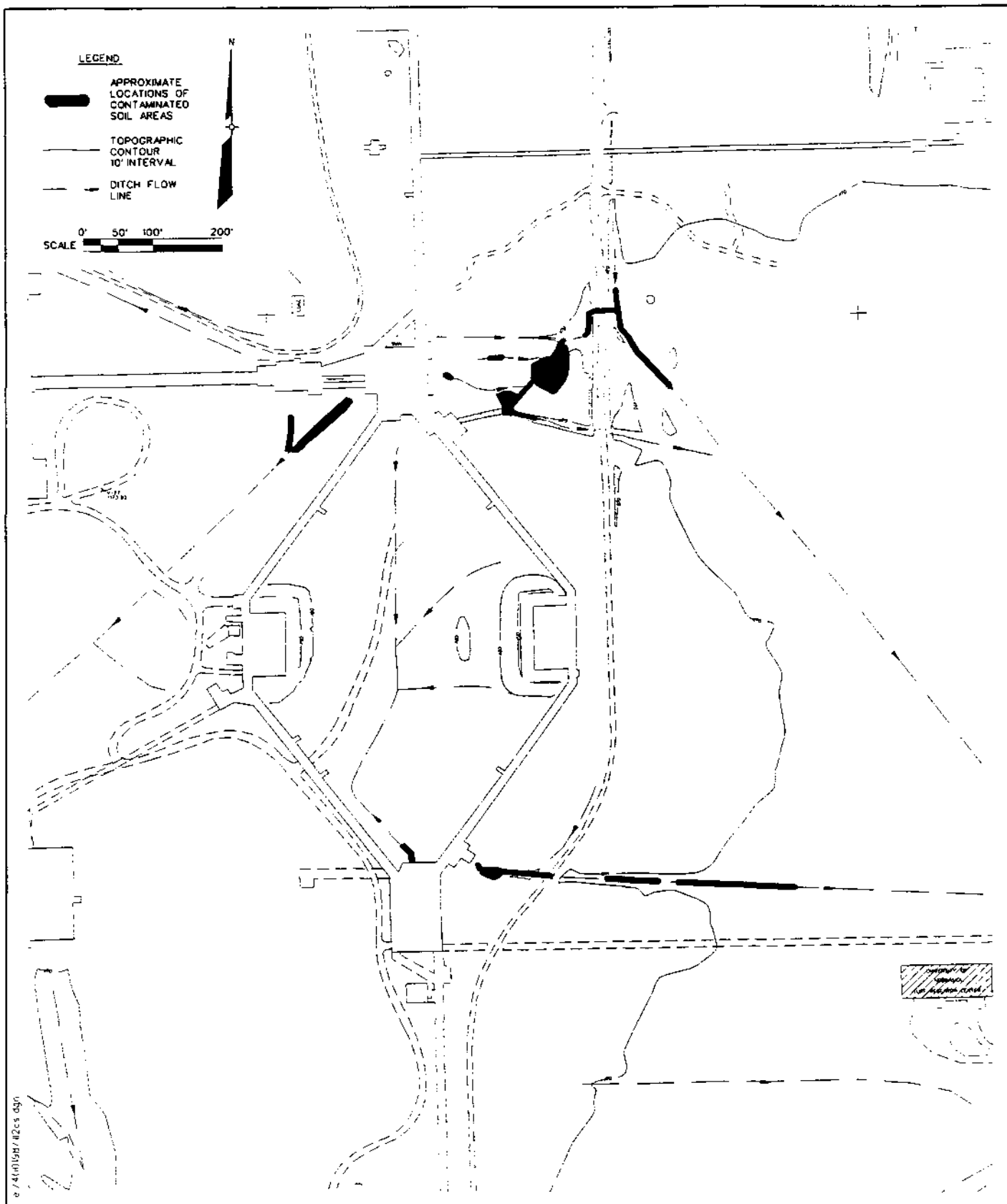


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FIGURE 3
LOAD LINE 1 - CONTAMINATED SOIL
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 FORMER NEBRASKA ORDNANCE PLANT
 MEAD, NEBRASKA

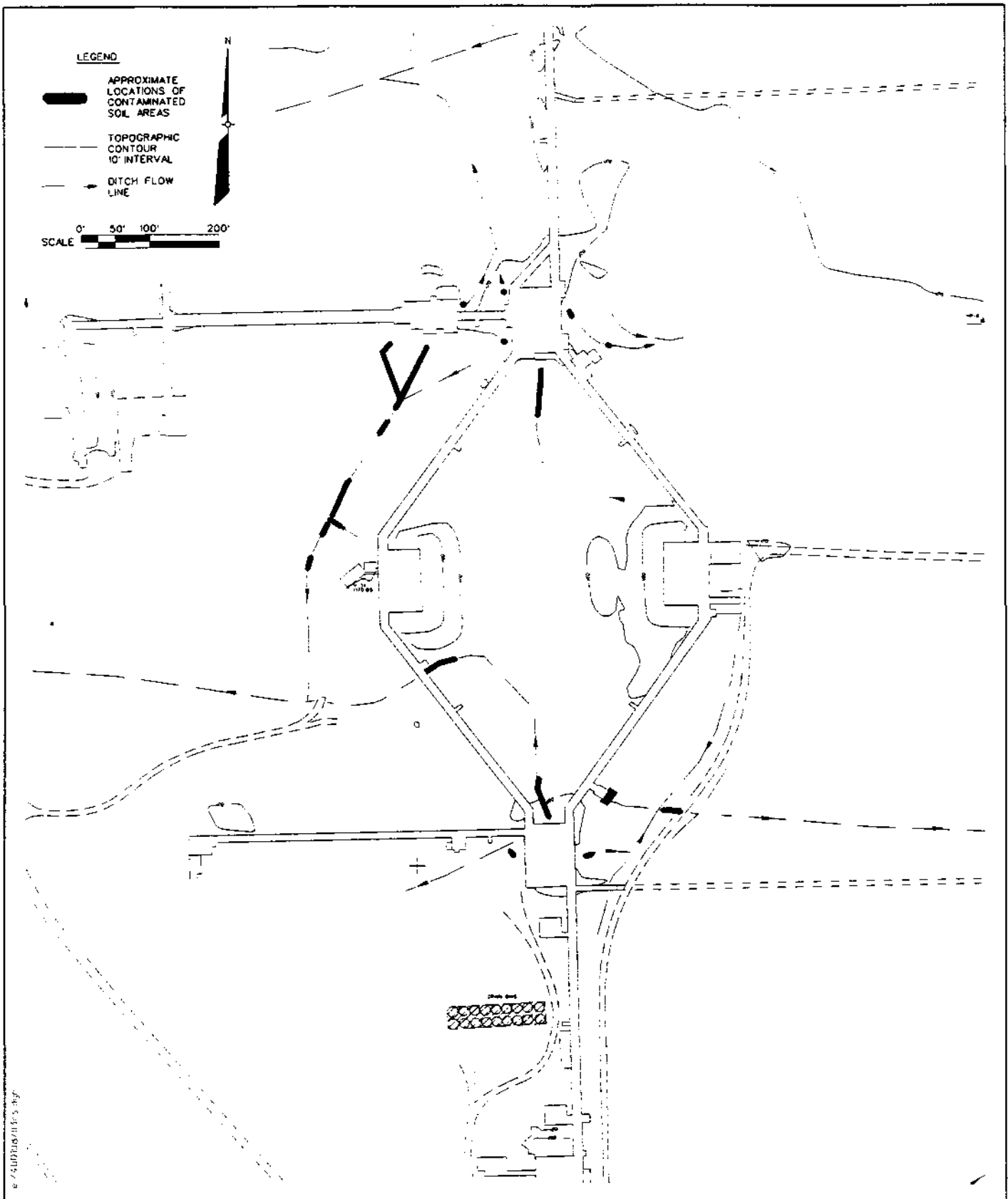


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FIGURE 4
LOAD LINE 2 - CONTAMINATED SOIL
 PREDESIGN TECHNICAL SUMMARY
 FORMER NEBRASKA ORDNANCE PLANT
 MEAD, NEBRASKA

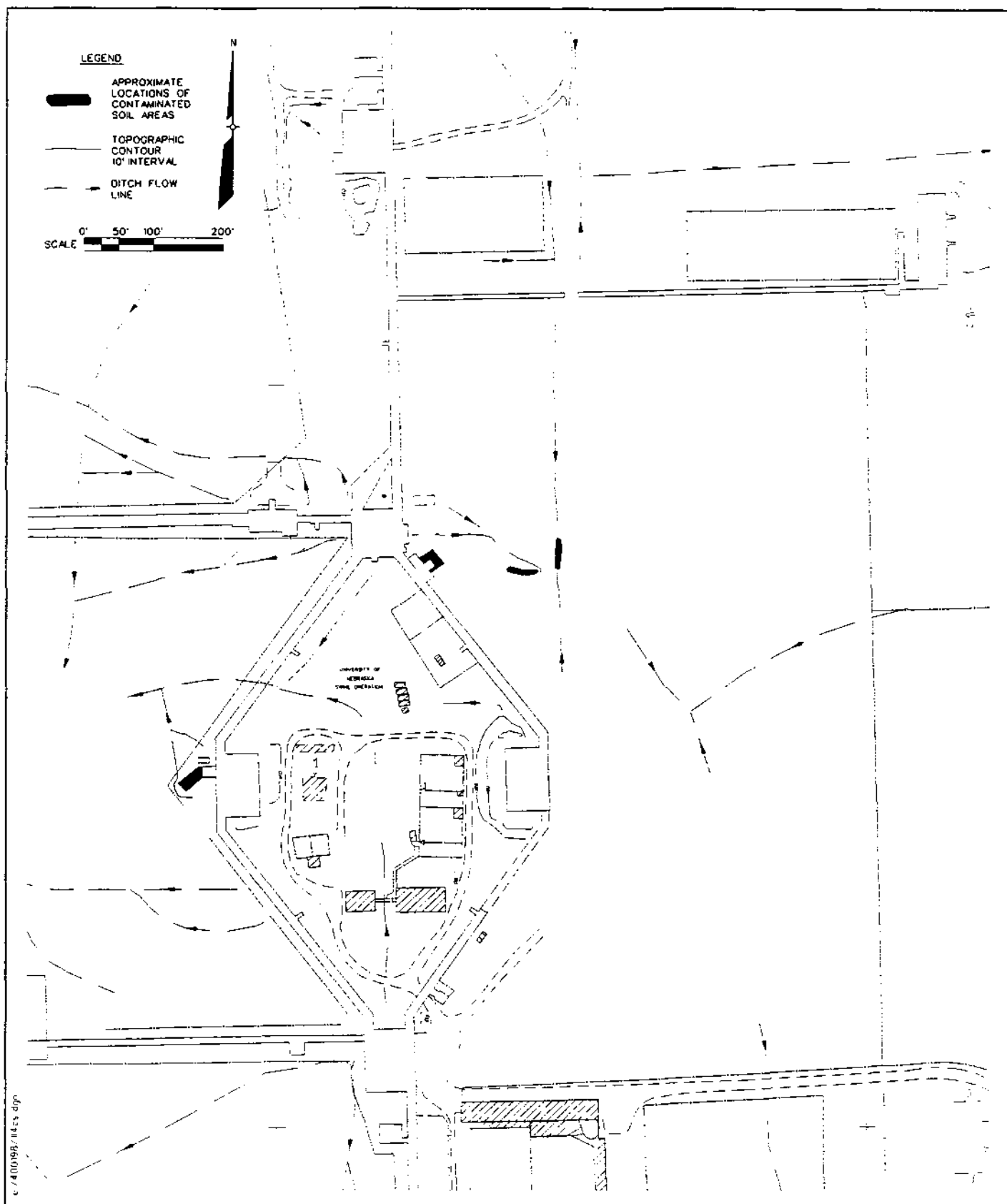


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FIGURE 5
LOAD LINE 3 - CONTAMINATED SOIL
 PREDESIGN TECHNICAL SUMMARY
 FORMER NEBRASKA ORDNANCE PLANT
 MEAD, NEBRASKA

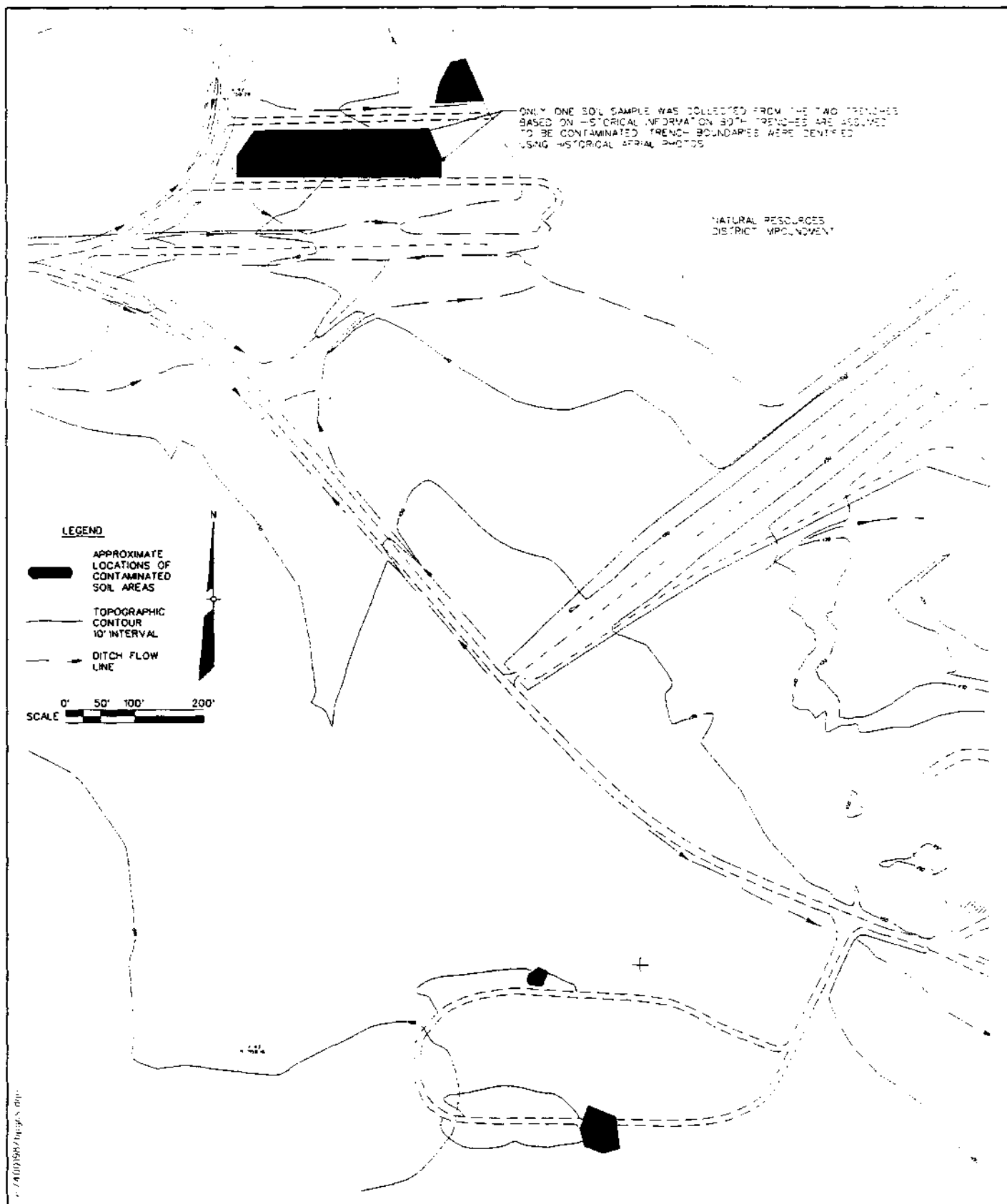


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FIGURE 6
LOAD LINE 4 - CONTAMINATED SOIL
 PREDESIGN TECHNICAL SUMMARY
 FORMER NEBRASKA ORDNANCE PLANT
 MEAD, NEBRASKA



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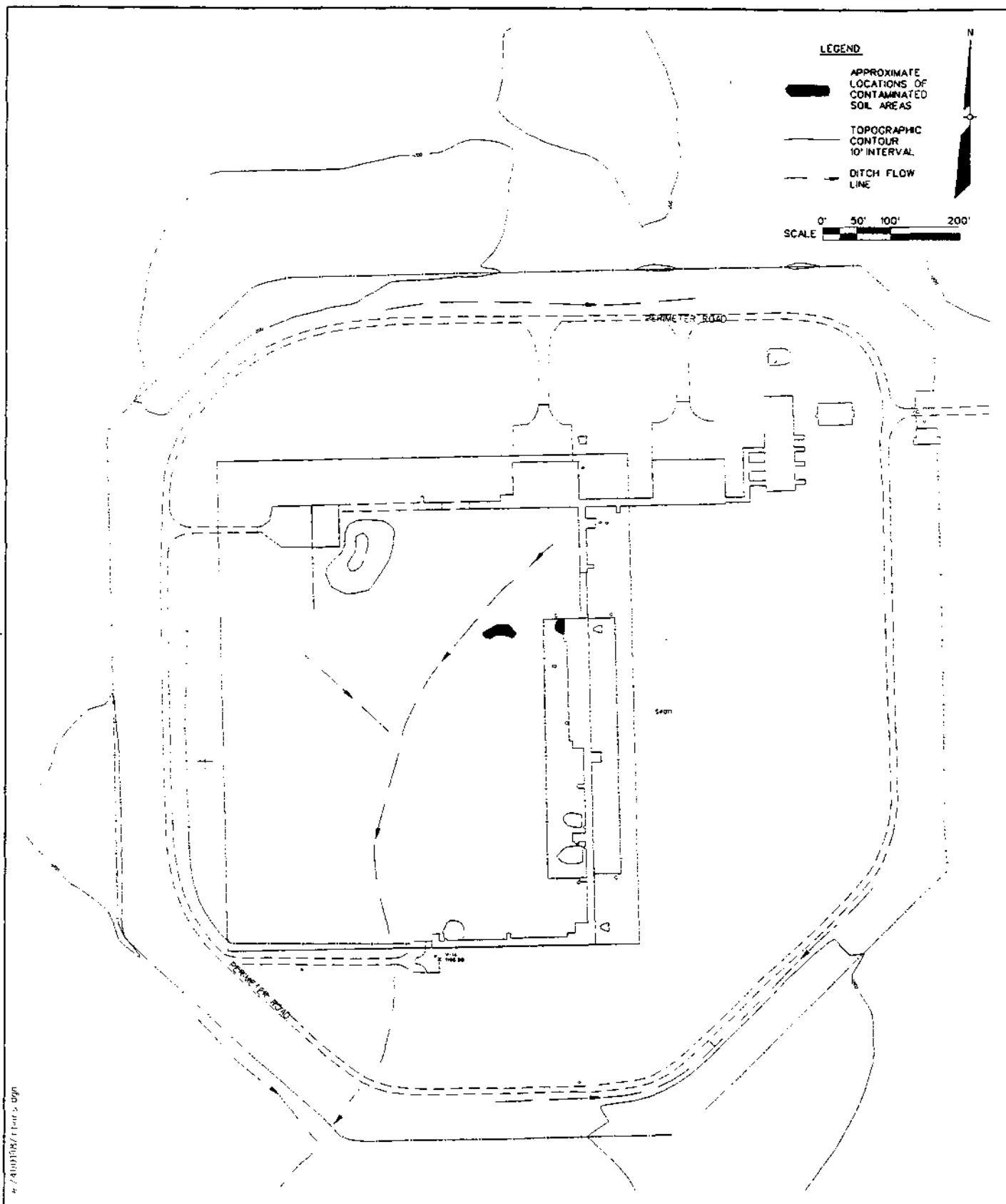
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FIGURE 7

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BURNING / PROVING GROUNDS
CONTAMINATED SOIL

PREDESIGN TECHNICAL SUMMARY
FORMER NEBRASKA ORDNANCE PLANT
MEAD, NEBRASKA



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FIGURE 8
BOMB BOOSTER ASSEMBLY AREA
CONTAMINATED SOIL
 PREDESIGN TECHNICAL SUMMARY
 FORMER NEBRASKA ORDNANCE PLANT
 MEAD, NEBRASKA

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TABLE 2
ESTIMATED AREA AND VOLUME OF CONTAMINATED SOIL

Subsite	Area (sf)	Volume (cu. yd.)
Load Line 1	13,000	1,900
Load Line 2	11,000	1,600
Load Line 3	4,500	670
Load Line 4	600	100
Burning/Proving Grounds	27,000	4,000
Bomb Booster Area	900	100
TOTAL	57,000	8,400

TABLE 3
TYPICAL SOIL PROPERTIES

USCS Soil Type:	CL and CH
Soil Description:	Silty clay, low to high plasticity
Soil pH:	6.2 to 6.5
Particle Size:	88 to 100% silt and clay, 0 to 12% sand
Moisture Content:	20 to 30%
Soil Unit Density (Dry):	87 to 94 lb/cu. ft.
Ash Fusion Temperature	450°C
Ash Content	Approximately 75%
Sources: USACE (1991), SEC Donohue (1992b), RUST (1993).	

5.2 REMEDIATION SCHEME

This section describes the components of the remediation scheme assumed for the purpose of this Predesign Technical Summary. The remedial design will develop and refine these components further. Based on the FS, the preliminary remediation scheme to be used at the site is shown in Figure 9. Figure 10 shows a sample process flow diagram for rotary kiln incineration, the incineration technology that will be used at the site.

5.2.1 Source Area Excavation

Excavation of the source areas is assumed for this document to include clearing and grubbing, soil and debris excavation, confirmation sampling, and stormwater control. Topsoil is assumed to be managed the same as contaminated soil. A sampling plan will be developed as a component of the Remedial Design to show how the lateral extent of excavation will be confirmed. For the purpose of the FS, it was assumed that confirmation sampling would take place in each 1,000 square feet of excavation surface from each of the four side walls of the excavation. Excavations will be backfilled with treated material.

As part of the predesign investigation, an explosives immunoassay field screen will be selected and used on the samples collected. The results will be correlated to laboratory data to determine if a field screen can be used to reduce the number of laboratory samples required at the time of construction to confirm the lateral extent of contamination.

Excavation of explosives-contaminated material will be performed primarily using standard excavation equipment because there is little indication of reactive soil. Two locations have been identified with potentially reactive concentrations. The excavation plan will be written to account for the necessary precautions in these areas. Stormwater run-on and run-off control will include temporary berms and ditches. Dust and erosion control are included for all excavation and materials handling operations.

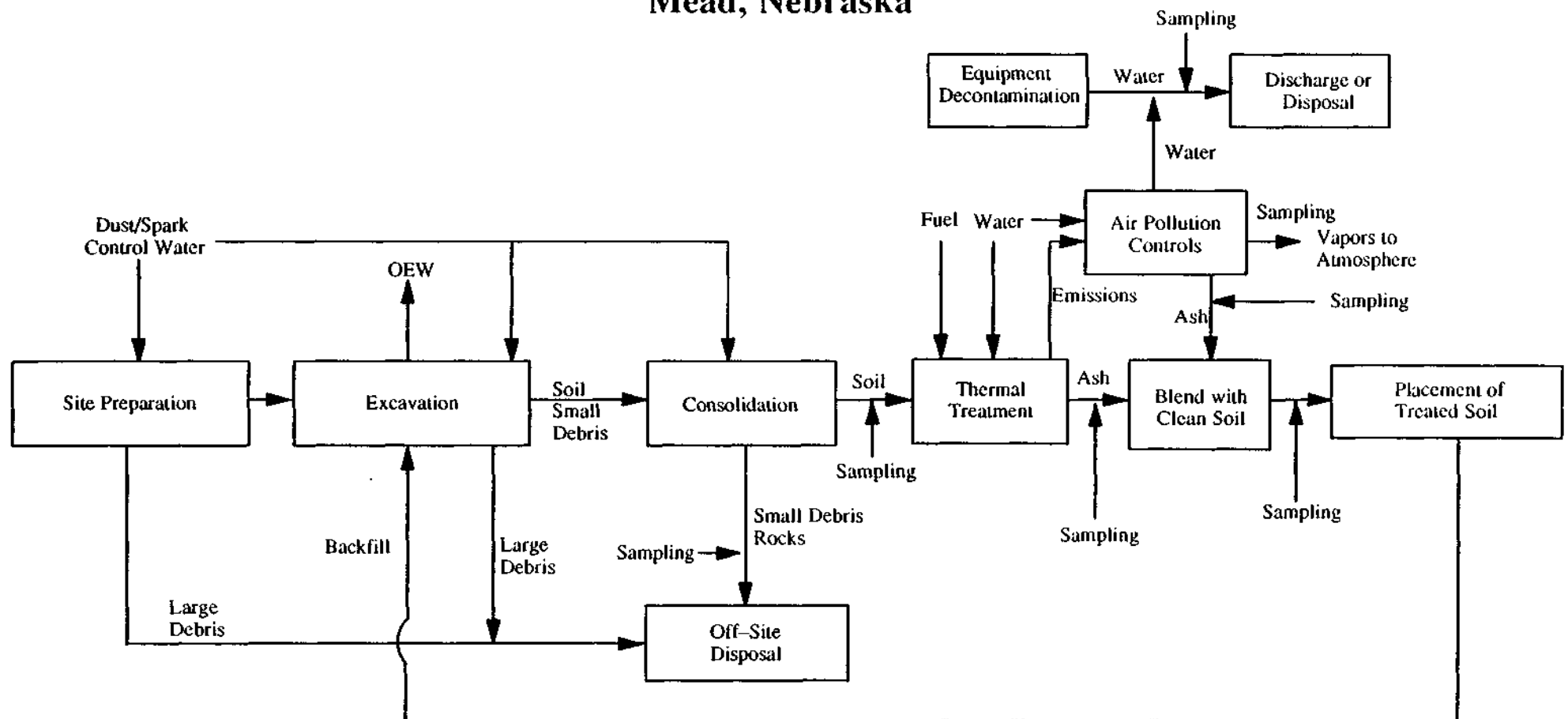
5.2.2 Consolidation of Excavated Materials

Consolidation includes transporting the contaminated material from source areas to a common site and preparing it for treatment. Consolidation will include a soil preprocessing structure. The structure will house activities such as blending, screening, and other preprocessing steps.

Debris and oversized (approximately 2 inches and over) particles may require size reduction prior to treatment or may be sampled to determine requirements for disposal. Addition of lime to the soil to be treated may be required to improve material handling characteristics, such as the tendency of clays to agglomerate. A grinder or shredder may also be needed to break up large agglomerations of soil before screening. Excavated soil will be stockpiled adjacent to the preprocessing building for characterization and staging. Stockpiles will be lined and covered with plastic sheeting.

FIGURE 9

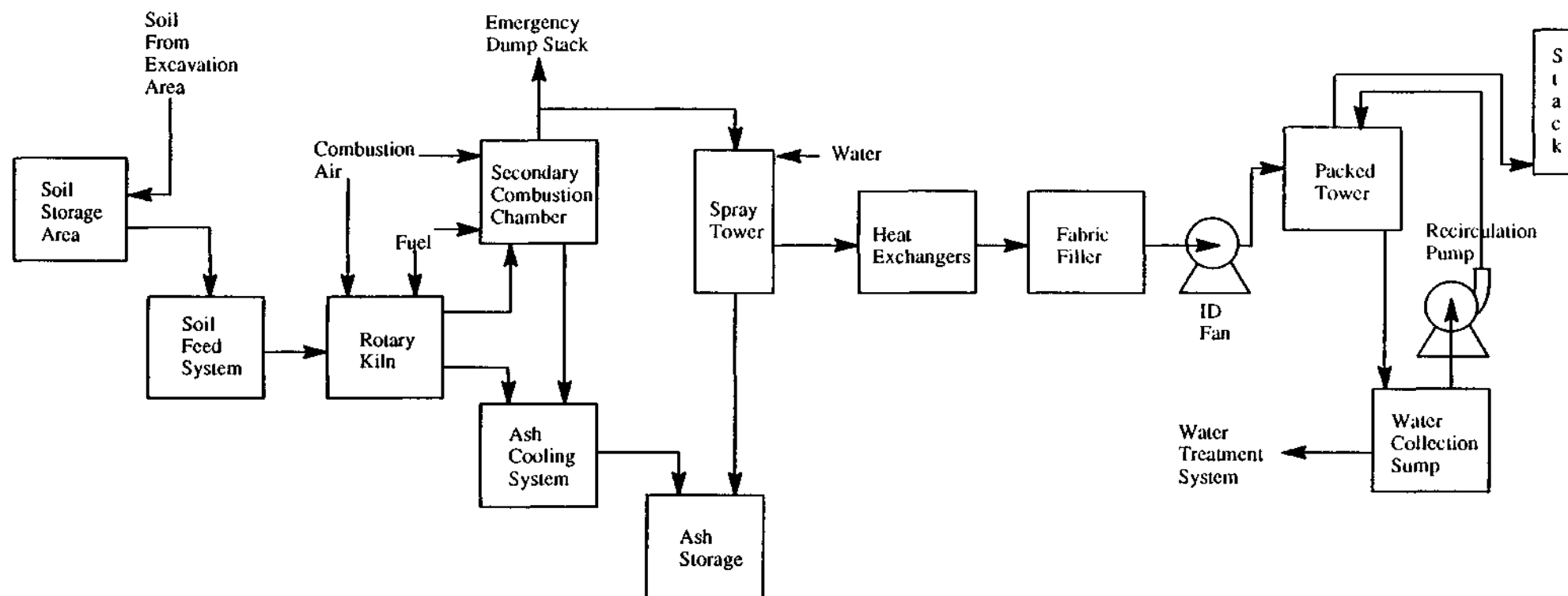
**PRELIMINARY COMPONENTS OF
REMEDATION SCHEME
Predesign Technical Summary
Former Nebraska Ordnance Plant
Mead, Nebraska**



OEW = Ordnance and Explosive Waste

FIGURE 10

ROTARY KILN PROCESS FLOW DIAGRAM
Predesign Technical Summary
Former Nebraska Ordnance Plant
Mead, Nebraska



Source: Cross/Tessitore & Associates

5.2.3 Debris Management

Surface debris located in source areas may require removal prior to excavation of explosives-contaminated soil. Surface debris may include wood, metal, concrete, trees, shrubs, and escape chutes. Trees and shrubs are assumed to be transported to the debris staging area where they will be shredded. Large subsurface debris separated during excavation, such as pipes and bucket trap concrete and metal, will be either shredded or reduced to a suitable hauling size. Samples will be collected to characterize the material for proper disposal off-site.

5.2.4 Thermal Treatment

Thermal treatment will be accomplished by rotary kiln incineration. The rotary kiln destroys contaminants by passing them through a high temperature rotating drum and a high temperature secondary combustion chamber. The rotary kiln will require an air pollution control system. A trial burn will also be required to show that performance and emissions control criteria are met.

Performance criteria beyond the remediation goals shown in Table 1 for the treatment unit have not yet been specified. Performance specifications will be developed under the design. The performance of the treatment unit will be monitored by residual characterization and continuous emissions monitoring. Performance will be measured by sampling and analysis of treated soil, which may consist of kiln ash and fly ash. Analyses will include explosives compounds of concern, TCLP metals, and geotechnical parameters. Results will determine whether the treated soil can be used as site backfill. Appendix B consists of justification for using TNT as the Principal Organic Hazardous Constituent (POHC). Indicator parameters for emissions will most likely consist of one or more of the compounds of concern. In addition, products of incomplete combustion (PICs), metals, chloride, and air permit-required parameters will be measured.

A rotary kiln treatability study was performed during the FS phase of the project. Procedures and results are detailed in the Draft Treatability Study Report (RUST 1993). The results of the treatability study indicated that rotary kiln treatment can meet the site RGs for explosives. They also indicate that residue produced would not be considered a hazardous waste. Based on the treatability studies and other design information, the minimum primary chamber operating conditions are estimated to be 22 minutes at 1500°F in a full scale unit with solids retention times of about 65 minutes.

It is further estimated based on the results of the treatability studies, that secondary chamber operation at 1800°F, with 2 seconds residence time and at least 3 percent excess oxygen will achieve a DRE of 99.99 percent. However, slagging in the rotary kiln may be a problem in both chambers due to the low ash fusion temperature. It will be necessary to monitor the mass feed rate of explosive compounds to hold nitrate/nitrite emissions to acceptable levels. A mass reduction of 26 percent and a volume reduction of 35 percent are anticipated under full scale conditions.

5.2.5 Residuals Management

Residuals will require treatment and/or disposal. It is assumed that treated soil will be returned to the areas from which it was excavated, and vegetated. Residuals for rotary kiln incineration could consist of kiln ash, fly ash, and scrubber water. Solid residuals should not require solidification/stabilization, prior to replacement into excavated areas and vegetation because the rotary kiln Treatability Study data indicate that the ash is not RCRA characteristic. However, samples will be required to confirm this during remediation. Clean soil may be mixed with ash or other soil after testing and prior to replacement to improve its physical properties and ability to support vegetation. Studies on thermally-treated soils have showed that they usually do not sustain plant life because all microbial agents which stimulate root growth and enhance essential nutrients uptake have been destroyed. In addition, some of the essential metal nutrients have been altered and are now bound with other metals which are not easily absorbed by the plant. Scrubber water can be used as quench water or for dust control.

Potential liquid waste streams have been identified for the remedy. Decontamination liquids (collected from the decontamination facility sump) will be generated during implementation. Thermal treatment process water (scrubber water) may be produced throughout thermal treatment. However, based on vendor conversations, it is assumed that scrubber water will be completely recycled (Chemical Waste Management 1992). Samples of residual liquids will be analyzed prior to discharge. Specific information concerning the control of potential liquid residuals will be addressed during the Remedial Design.

5.3 LONG-TERM MONITORING

No long-term monitoring is expected to be necessary for this remedial action. Once treatment is complete, treated soil meeting the remediation goals will be combined with clean soil, as necessary, to sustain vegetation, and returned to source areas. Soil above 4 feet will not contain contaminants above risk-based RG levels, so long-term monitoring and a five-year review of the OU 1 remedy will not be required.

5.4 FLEXIBILITY IN DESIGN

This section evaluates the technology and material restrictions during design and construction.

The remediation technology that will be named in the ROD is on-site rotary kiln incineration. A treatability study was performed for rotary kiln incineration using soil collected at this site. The study showed that the soil can be successfully treated to meet RGs. Because the ROD is being written specifically as "rotary kiln incineration," there will not be flexibility to allow for using other thermal treatment technologies without issuing an amendment to the ROD. Due to the expected use of a preplaced contractor, some flexibility in the design is lost. However, use of a preplaced contractor does allow for coordination between designer and contractor through the design. Because the specifications for the remedial action will be performance based, there will be flexibility to vary components and materials of the remedy to meet the performance criteria.

5.5 SCHEDULE CONSTRAINTS

According to the Interagency Agreement signed by the Department of the Army, USEPA, and the Nebraska Department of Environmental Quality (NDEQ), and Section 120(e)(2) of CERCLA, the Army must "commence substantial and continuous physical on-site remedial action at the site within fifteen months" of the date of the signing of the ROD. This is the only known schedule constraint for remedial design. Since treatability studies have already been performed for the remedial process option considered and rotary kiln incineration is a proven, frequently used technology, this constraint is not expected to pose a burden on the Army, its designer, or the contractor performing the work.

Poor weather could cause a constraint on the design if it significantly delays the predesign investigation. However, significant delays due to weather are not likely.

5.6 OU 2 CONSIDERATIONS

As discussed in Section 4.1, soil not previously defined in the OU 1 FS (based on EPA RGs) which may act as a source of explosives contamination to groundwater (which is currently being investigated under OU 2), if addressed under OU 1 remedial action, will affect the OU 1 remedial design. However, the OU 1 and OU 2 schedules do not allow for a decision on the addition of OU 2 soil until the OU 1 design has begun. This document and any plans and reports written for OU 1 prior to the decision on including OU 2 soil in the OU 1 remedial action will be written based on the assumption that OU 2 soil will not be treated under the OU 1 remedial action. Therefore, they will incorporate the assumptions and conclusions developed under OU 1 only. For example, the current Field Investigation Plan (FIP) Addendum written for the Predesign Investigation will be developed only to further define the areas and volumes based on RGs developed under OU 1. Contingent sampling strategies will not be developed in the current FIP Addendum to address additional volume defined by RGs developed under OU 2.

6.0 QUANTITY ESTIMATES AND IMPLICATIONS

This section describes the basis for the remediation quantity, the certainty of the estimate, and how changes in the quantity will affect space and material requirements.

6.1 VOLUME ESTIMATION

Volumes of contaminated soil given in Table 2 and areas shown in Figures 3 through 8 are based on RGs and sampling performed during the RI. Assumptions used to estimate contaminated areas and volumes are included in the FS Report. One of the assumptions was that washwater ditch widths are 8 feet. Cross-sectional survey data, transect boring data (samples at intervals perpendicular to the ditches), and historical data will be re-evaluated during the design, and quantities may be re-estimated.

Predesign sampling is being conducted to:

- Verify positive field screen data where no lab samples were taken and historical activities suggest that there is a potential for contamination.
- Further define source areas previously delineated using OU 1 RGs where volumes were estimated conservatively due to a lack of samples.

Results of the Predesign Investigation will be used to refine the contaminated volume estimate and reported in the Predesign Report. Although the predesign investigation will further define remediation areas, there will still be some uncertainty in the remediation quantity. Significant volume increase would affect the design, duration, and cost of the remedial action.

6.2 REAL ESTATE REQUIREMENTS

The remediation contractor will require space for soil and debris staging areas and preprocessing and treatment facilities. The stockpile area will be lined, probably with a geomembrane, and stockpiles will be covered to prevent airborne dust emission, and infiltration of rainfall. For the estimated total volume of 8,400 cubic yards of material, approximately 1 acre will be required for staging.

Additional staging areas will be required for debris and oversized materials, and for treated soil and ash. These areas will be used for storage of these materials during laboratory analytical turn-around time, before the material is moved for its ultimate disposition. These staging areas will also require geomembrane liners. It is assumed that approximately one-half acre will be sufficient for these staging areas, based on FS estimates.

The space required for remediation activities will be leased to the Army by the University. The University of Nebraska has expressed a preference for remedial activities to take place inside one of the "diamond" areas of the load lines. One of these areas (approximately 5.5 acres) will not

be sufficient for all remediation activities. Coordination between the Army, designer, and University will be required to select an efficient layout that minimizes impacts to University activities. It is assumed that an increase in volume above the estimate made following the Predesign Investigation will not require additional real estate.

6.3 DURABILITY OF MATERIALS

Material durability is a function of the chemical characteristics of the soil (e.g., corrosivity or reactivity) being handled and the duration of contact between material and soil. Chemical data on the soil indicates that the soil has no harsh characteristics that could affect materials used. DOD explosive hazard analyses may be required for equipment and operations. During the Feasibility Study, it was estimated that the duration of the remedial action treating 8,400 cubic yards will be approximately 18 months. It is not anticipated that any materials durability issues will arise during this implementation time. It is assumed that any increase in volume above the estimate made following the Predesign Investigation will not significantly affect the implementation time estimated for that quantity.

7.0 FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATORY REQUIREMENTS

7.1 INTRODUCTION

This section identifies and discusses federal, state, and local environmental applicable or relevant and appropriate requirements (ARARs) for the OUI remediation at the former NOP site. The ARARs discussion is divided into the following components of the remedial action:

- Soil removal, material handling, and site preparation/restoration.
- Rotary kiln incineration.
- Residuals management.

The specific citations in this section are only a summary of the substantive ARARs requirements. The complete text of the ARARs should be reviewed during the design.

7.2 SOIL REMOVAL, MATERIAL HANDLING, AND SITE PREPARATION/RESTORATION

This section presents an analysis of the federal, state, and local ARARs affecting the soil removal, material handling, and site preparation/restoration portions of the selected OUI remedial action. None of the materials to be moved or handled have been identified as a RCRA hazardous waste. The following elements are considered in this section:

- Construction of decontamination facility.
- Placement of support facilities.
- Access road improvement.
- Tree clearing, grubbing and topsoil stripping.
- Excavation of contaminated soil from source areas.
- Manual separation of debris and debris shredding (if necessary).
- On-site hauling and stockpiling of contaminated material.
- Screening, grinding, and blending of soil in an enclosed structure.
- Blending of solid treatment residuals with clean soil (if necessary for geotechnical stability or to sustain vegetation).
- Return of blended solid treatment residuals to source areas.
- Facilities removal and revegetation of affected areas.

Federal and state ARARs pertinent to these elements are summarized in Table 4.

7.2.1 Federal ARARs

The Clean Air Act (CAA) is the only federal ARAR that has been identified as pertinent to the elements listed above. The objective of the CAA is to protect and enhance the quality of the nation's air resources in order to promote and maintain public health and welfare and the nation's production capacity. The programs within the CAA that contain potential ARARs for the soil

TABLE 4
ARARS WITH SUBSTANTIVE REQUIREMENTS FOR SOIL REMOVAL,
MATERIAL HANDLING, AND SITE PREPARATION/RESTORATION

LAWS	RULES AND REGULATION	DESCRIPTION	CLASSIFICATION	AFFECTED PORTION OF REMEDY	SUBSTANTIVE REQUIREMENTS
FEDERAL					
Clean Air Act (CAA) of 1963, as amended [42 U.S.C. 7401]					
40 CFR 50 - National Primary and Secondary Ambient Air Quality Standards	40 CFR 50.6	National primary and secondary ambient air quality standards for particulate matter.	Chemical	Stockpiles, excavation, materials handling, and site work.	Limits the maximum 24-hour average ambient concentration of particulate matter (PM ₁₀) to 150 ug/m ³ not to be exceeded more than once per year and the annual arithmetic mean to 50 ug/m ³ as measured by the test method specified in 40 CFR 50 Appendix J and averaging method specified in 40 CFR 50 Appendix K.
40 CFR 61 - National Emission Standards for Hazardous Air Pollutants	40 CFR 61.01	Identifies substances that have been designated hazardous air pollutants, and for which a Federal Register notice has been published.	Chemical	Stockpiles, excavation, materials handling, and site work.	Determine whether designated hazardous air pollutants are present.
	40 CFR 61.05-06	Specifies prohibited activities, describes procedures for determining whether construction or modification is involved, prescribes methods of applying for approval, and covers manner in which startup notification is to be provided.	Action	Stockpiles, excavation, materials handling, and site work.	If hazardous air pollutants are present, regulatory approval must be obtained to construct or modify a source of pollutants.
	40 CFR 61.10-11	Specifies source reporting and waivers of compliance with a standard.	Chemical	Stockpiles, excavation, materials handling, and site work.	If hazardous air pollutants are present, follow reporting/waiver requirements.

TABLE 4 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR SOIL REMOVAL,
MATERIAL HANDLING, AND SITE PREPARATION/RESTORATION

Laws	Rules and Regulation	Description	Classification	Affected Portion of Remedy	Substantive Requirements
40 CFR 61 - National Emission Standards for Hazardous Air Pollutants (cont.)	40 CFR 61.12-14	Specifies compliance with emission standards. Also, specifies regulations for emission tests and monitoring requirements.	Chemical	Stockpiles, excavation, materials handling, and site work.	If hazardous air pollutants are present, follow compliance, testing, and monitoring requirements.
	40 CFR 61.15	Defines modification to a stationary source and specifies tasks that must be performed in the event that a modification is performed.	Action	Stockpiles, excavation, materials handling, and site work.	If modification of hazardous air pollutant source is necessary, follow requirements to determine whether an increase in emissions has occurred.
	40 CFR 61.19	Prohibits concealing emissions	Chemical	Stockpiles, excavation, materials handling, and site work.	Emissions shall not be concealed.
STATE					
Nebraska Environmental Protection Act					
Nebraska Air Pollution Control Regulations	Title 129 Chapter 2	Establishes air quality control regions.	Location	Excavation, materials handling, and site work.	Determine local air quality region.
	Title 129 Chapter 3	Establishes State primary and secondary ambient air quality standards for particulate matter.	Chemical	Excavation, materials handling, and site work.	PM ₁₀ Primary and Secondary Limits: 50 ug/m ³ annual arithmetic mean, 150 ug/m ³ 24-hour average not to be exceeded over 1 day/year. Particulate Matter Primary Limit: 75 ug/m ³ annual geometric mean, 260 ug/m ³ 24-hour concentration not exceeded over 1 day/year. Particulate Matter Secondary Limit: 60 ug/m ³ annual geometric mean, 150 ug/m ³ 24-hour maximum not to be exceeded over 1 day/year.

TABLE 4 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR SOIL REMOVAL,
 MATERIAL HANDLING, AND SITE PREPARATION/RESTORATION

Laws	Rules and Regulation	Description	Classification	Affected Portion of Remedy	Substantive Requirements
Nebraska Air Pollution Control Regulations (cont.)	Chapter 7	Adopts 40 CFR 52 (CAA state implementation plans) regarding Prevention of Significant Deterioration of Air Quality	Chemical	Excavation, materials handling, and site work.	Sets maximum allowable emissions increases to trigger modification of state implementation plan.
	Chapter 17	Prohibits visible dust beyond the limits of the property line where handling, transportation, or construction is taking place.	Action	Excavation, materials handling, and site work.	Apply reasonable measures to prevent particulate matter from becoming airborne so that it remains visible off-site.
	Chapter 24	Limits visible emissions from diesel-powered construction or transportation equipment.	Action	Excavation, materials handling, and site work.	Diesel-powered vehicles used on public streets shall not emit exhaust equal to or darker than 20% opacity or designation No. 1 on the Ringelmann Chart for longer than 10 seconds.

removal, material handling, and site preparation/restoration components of the remediation are the National Ambient Air Quality Standards (NAAQS) for Criteria Pollutants, and the National Emission Standards for Hazardous Air Pollutants (NESHAP).

NAAQS for six pollutants (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur oxides) appear in the Code of Federal Regulation (CFR) in 40 CFR 50. These standards are based on the direct health effects of these pollutants to sensitive groups, with no consideration to economic factors. The NAAQS take all sources to a given pollutant into account and establish ceilings that are not to be exceeded in the United States. NAAQS apply only to major sources as defined under this program. Soil removal, material handling, and site preparation/restoration activities do not constitute a major source. However, the ceiling for particulate matter is relevant and appropriate to these activities.

In general, new sources of air emissions must undergo a pre-construction review. Pre-construction reviews are conducted to determine whether a new source will interfere with attainment or maintenance of NAAQS. The permitting process associated with attainment of NAAQS applies only to major sources of air emissions. However the substantive requirement of the permitting process, a pre-construction review, is a substantive requirement for the former NOP site OU1 remediation. The review will evaluate total emissions, including fugitive emissions generated by soil removal, material handling, and site preparation/restoration as well as by the treatment component of the remediation.

Although none of the compounds detected in OU1 soil are included in the list of hazardous air pollutants or the list of substances for which a Federal Register notice has been published regarding serious health effects from ambient air exposure to the substance, NESHAPs are considered an ARAR in the case that such compounds are detected. In general, the NESHAP regulations give emissions limits for hazardous air pollutants and mandate various testing, monitoring, and reporting requirements.

7.2.2 Nebraska ARARs

One state ARAR, the Nebraska Air Pollution Control Regulations- Title 129, is applicable to the activities covered in this section. Pertinent chapters of this ARAR are included in Table 4. The substantive requirements of the Nebraska Air Pollution Control Regulations are relevant and appropriate to soil removal, material handling, and site work activities. Substantive requirements currently identified are:

- Demonstrate compliance with state primary and secondary ambient air quality standards for particulate matter.
- Limit visible dust and equipment emissions.
- Prevent significant deterioration of air quality.

7.3 ROTARY KILN INCINERATION

This section presents an analysis of the federal and state ARARs affecting the on-site rotary kiln incineration portion of the OU1 remediation. This analysis addresses requirements for the design and performance of the treatment system.

7.3.1 Federal ARARs

The following federal environmental regulations have been identified as potential ARARs for the rotary kiln incineration portion of the remedial action:

- Clean Air Act (CAA).
- Resource Conservation and Recovery Act (RCRA).

The following sections briefly discuss these regulations and why they are pertinent to the incineration portion of the OU1 remediation. Pertinent rules and regulations are summarized in Table 5.

7.3.1.1 Clean Air Act

Programs within the CAA that contain ARARs for the rotary kiln incineration portion of the remediation are:

- National Ambient Air Quality Standards (NAAQS) for Criteria Pollutants.
- National Emission Standards for Hazardous Air Pollutants (NESHAPs).
- New Source Performance Standards (NSPS) for Criteria and Designated Pollutants.

Each program is described in further detail below.

NAAQS

Section 7.1.2 provides the general description of NAAQS. The incinerator that will be used at the former NOP site does not constitute a major source of air emissions. However, the NAAQS for particulates and other pollutants are relevant and appropriate to the rotary kiln. As discussed in section 7.1.2, the pre-construction review is a substantive requirement that will consider all sources of emissions at the site.

NSPS

NSPSs apply to incinerators that treat waste containing more than 50 percent municipal solid waste. Therefore, this ARAR is not applicable but is relevant and appropriate to rotary kiln incineration. The particulate matter effluent standards, monitoring requirements, test methods, and procedures for incinerators are substantive requirements for the OU1 remediation.

TABLE 5
ARARS WITH SUBSTANTIVE REQUIREMENTS FOR INCINERATION

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
FEDERAL					
Clean Air Act (CAA) of 1963, as amended [42 U.S.C. 2401]					
40 CFR 50 - National Primary and Secondary Ambient Air Quality Standards	40 CFR 50.4	National primary ambient air quality standards for sulfur dioxide.	Chemical	Incinerator Operations	Limits annual arithmetic mean concentration to 80 ug/m ³ , maximum 24-hour concentration to 365 ug/m ³ , not to be exceeded over 1 day per year.
	40 CFR 50.5	National secondary ambient air quality standards for sulfur dioxide.	Chemical	Incinerator Operations	Limits maximum 3-hour concentration to 1,300 ug/m ³ , not to be exceeded over 1 day per year.
	40 CFR 50.6	National primary and secondary air quality standards for particulate matter.	Chemical	Incinerator Operations	Limits the maximum 24-hour average ambient concentration of particulate matter (PM ₁₀) to 150 ug/m ³ not to be exceeded more than once per year and the annual arithmetic mean to 50 ug/m ³ as measured by the test method specified in 40 CFR 50 Appendix J, and averaging method specified in 40 CFR 50 Appendix K.
	40 CFR 50.8	National primary air quality standards for carbon monoxide.	Chemical	Incinerator Operations	Limits maximum 8-hour average to 10 mg/m ³ , maximum 1-hour average to 40 mg/m ³ , not to be exceeded more than 1 day per year. Reference method as given in 40 CFR Appendix C.
	40 CFR 50.9	National primary and secondary air quality standards for ozone.	Chemical	Incinerator Operations	Sets maximum hourly average concentration at 235 ug/m ³ , as measured by method given in 40 CFR 50 Appendix D, averaged as in 40 CFR 50 Appendix H.
	40 CFR 50.11	National primary and secondary air quality standards for nitrogen dioxide.	Chemical	Incinerator Operations	Sets primary and secondary limits at 100 ug/m ³ annual arithmetic mean concentration using method designated in 40 CFR 50 Appendix F.
	40 CFR 50.12	National primary and secondary air quality standards for lead.	Chemical	Incinerator Operations	Sets primary and secondary limits at 1.5 ug/m ³ maximum quarterly arithmetic mean as measured by a method specified in 40 CFR 50 Appendix G.

TABLE 5 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR INCINERATION

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
40 CFR 60 - Standards for Performance for New Stationary Sources	40 CFR 60.50	Applicability of performance standards for incinerators.	Action	Incinerator Operations	40 CFR 60.50 Series (Subpart E) applicable to incinerators capable of processing over 50 tons/day.
	40 CFR 60.51	Definitions	Action	Incinerator Operations	Defines terms used in Subpart E.
	40 CFR 60.52	Particulate matter standards.	Action	Incinerator Operations	Sets particulate matter limit to 0.18 g/dscm when corrected to 12% CO ₂ .
	40 CFR 60.53	Monitoring of operations.	Action	Incineration Operations	Daily charging rates and hours of operation must be recorded.
	40 CFR 60.54	Test methods and procedures.	Action	Incinerator Operations	Gives testing methods and procedures for calculating percent CO ₂ and excess air.
40 CFR 61 - National Emissions Standards for Hazardous Air Pollutants	40 CFR 61.01	Identifies substances that have been designated hazardous air pollutants, and for which a Federal Register notice has been published.	Chemical	Incinerator Operations	Determine whether designated hazardous air pollutants are present.
	40 CFR 61.05-06	Specifies prohibited activities, describes procedures for determining whether construction or modification is involved, prescribes methods of applying for approval, and covers manner in which startup notification is to be provided.	Action	Incinerator Operations	If hazardous air pollutants are present, regulatory approval must be obtained to construct or modify a source of pollutants.
	40 CFR 61.10-11	Specifies source reporting and waivers of compliance with a standard.	Chemical	Incinerator Operations	If hazardous air pollutants are present, follow reporting/waiver requirements.

TABLE 5 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR INCINERATION

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
40 CFR 61 - National Emissions Standards for Hazardous Air Pollutants (cont.)	40 CFR 61.12-14	Specifies compliance with emission standards. Also, specifies regulations for emission tests and monitoring requirements.	Chemical	Incinerator Operations	If hazardous air pollutants are present, follow compliance, testing, and monitoring requirements.
	40 CFR 61.15	Defines modification to a stationary source and specifies tasks that must be performed in the event that a modification is performed.	Action	Incinerator Operations	If modification of hazardous air pollutant source is necessary, follow requirements to determine whether an increase in emissions has occurred.
	40 CFR 61.19	Prohibits concealing emissions.	Chemical	Incinerator Operations	Emissions shall not be concealed.
Solid Waste Disposal Act (SWDA) as Amended by Resource Conservation and Recovery Act (RCRA OF 1976 [42 U.S.C. 6901]					
40 CFR 261 - Identification and Listing of Hazardous Wastes	40 CFR 261.1-7,10, 11,20-24,30-33	Definition of Solid and Hazardous Wastes.	Chemical	Incinerator Operations	RCRA regulations are not applicable, but relevant and appropriate, as OU1 soil is not defined as a hazardous waste. However, solid treatment residuals will require testing by the toxicity characteristic leaching procedure to determine if they are hazardous.
40 CFR 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 264.340	Applicability.	Action	Incinerator Operations	Determine whether 40 CFR 264.340-351 (Subpart O) regulations apply.
	40 CFR 264.341	Waste analysis.	Action	Incinerator Operations	Specifies that waste feed analysis is required.
	40 CFR 264.342	Principal organic hazardous constituents (POHCs).	Action	Incinerator Operations	Select a POHC to be designated for performance of trial burn.
	40 CFR 264.343	Performance standards.	Action	Incinerator Operations	Designates destruction and removal efficiency (DRE) for POHCs of 99.99% unless one of a specified list of waste types is incinerated. HCl emissions are limited to 1.8 kg/hr. Particulate matter is limited to 180 mg/dscm.

TABLE 5 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR INCINERATION

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
40 CFR 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (cont.)	40 CFR 264.344	Hazardous waste incinerator permits.	Action	Incinerator Operations	No hazardous waste incineration may occur except in trial burns or other exceptions listed in this regulation.
	40 CFR 264.345	Operating requirements.	Action	Incinerator Operations	Permit will specify CO level in exhaust, waste feed rate, combustion temperature, indicator of gas velocity, allowable design or procedure variations, and other necessary requirements.
	40 CFR 264.347	Monitoring and inspections.	Action	Incinerator Operations	Monitor combustion temperature, waste feed rate, gas velocity, CO. Sample waste and exhaust as requested by USEPA. Daily visual inspection of incinerator and associated equipment. Testing of emergency waste feed cutoff.
	40 CFR 264.351	Closure	Action	Incinerator Operations	All waste and residue must be removed from site at closure.
	40 CFR 270.62	Hazardous waste incinerator permits.	Action	Incinerator Operations	Describes permit conditions including trial burn plan to be submitted.
STATE					
Nebraska Environmental Protection Act					
Nebraska Air Pollution Control Regulations	Title 129, Chapter 3	Ambient air quality standards.	Chemical	Incinerator Operations	Sets maximum standards for ambient air. Primary Standards - PM_{10} : 50 $\mu\text{g}/\text{m}^3$ annual arithmetic mean, 150 $\mu\text{g}/\text{m}^3$ 24-hour average; Particulates: 75 $\mu\text{g}/\text{m}^3$ annual geometric mean, 260 $\mu\text{g}/\text{m}^3$ 24-hour average; SO_2 : 80 $\mu\text{g}/\text{m}^3$ annual arithmetic mean, 365 $\mu\text{g}/\text{m}^3$ 24-hour average; NO_2 : 100 $\mu\text{g}/\text{m}^3$ annual arithmetic mean; CO: 10 mg/m^3 maximum 8-hour average, 40 mg/m^3 maximum 1-hour concentration; Ozone: 235 $\mu\text{g}/\text{m}^3$ 1-hour concentration; Lead: 1.5 $\mu\text{g}/\text{m}^3$ calendar quarter arithmetic mean. Secondary Standards - PM_{10} , NO_2 , CO, Ozone, and Lead: Same as primary, Particulates: 60 $\mu\text{g}/\text{m}^3$ annual geometric mean, 150 $\mu\text{g}/\text{m}^3$ 24-hour concentration; SO_2 : 1300 $\mu\text{g}/\text{m}^3$ 3-hour concentration.

TABLE 5 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR INCINERATION

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
Nebraska Air Pollution Control Regulations (cont.)	Title 129, Chapter 4	Reporting and Operating Permits.	Action	Incinerator Operations	Describes reporting and permitting requirements.
	Title 129, Chapter 5	Stack Heights: Good engineering practice.	Action	Incinerator Operations	Stack height shall not exceed good engineering practice.
	Title 129, Chapter 6	New, modified, and reconstructed sources; standards of performance; application for permit, when required; requirements for new, modified, or reconstructed sources of toxic air pollutants.	Action	Incinerator Operations	Adopts by reference 40 CFR Part 60 and 61 rules, describes application and permit, requires best available control technology for toxic air pollutants.
	Title 129, Chapter 7	Prevention of significant deterioration of air quality.	Action	Incinerator Operations	Permit shall be written such that no significant deterioration of air quality occurs.
	Title 129, Chapter 11	Incinerates, emissions standards	Action	Incinerator Operations	Relevant and appropriate requirement regarding municipal waste incinerators. Particulates may not exceed 0.10 g/dscf in exhaust, corrected to 12% CO ₂ .
	Title 129, Chapter 17	Dust, duty to prevent escape of.	Action	Incinerator Operations	All reasonable measures shall be applied to prevent fugitive dust emissions.

NOTES:

PM₁₀ = Particulate matter of less than 10 micrometers in average diameter.
 ug/m³ = Micrograms per cubic meter.
 mg/m³ = Milligrams per cubic meter.
 g/dscf = Grains per dry standard cubic foot.
 g/dscm = Grains per dry standard cubic meter.
 CO₂ = Carbon dioxide.
 CO = Carbon monoxide.
 NO₂ = Nitrogen dioxide.
 SO₂ = Sulfur dioxide.

NESHAPs

NESHAPs for industrial sources that emit specific pollutants are established in 40 CFR 61. Generally, NESHAPs are not ARARs for cleanup actions at CERCLA sites because they regulate particular types of sources that are not expected to be found at CERCLA sites. Some of the pollutant standards may be relevant and appropriate for the pre-construction review that will be conducted under the NAAQS program.

7.3.1.2 Resource Conservation and Recovery Act

RCRA consists of nine sections or subtitles. Subtitle C, Hazardous Waste Management, regulates the treatment, storage and disposal of hazardous wastes. These regulations are presented in 40 CFR 260 through 40 CFR 272. The explosives-contaminated soil that will be treated is not a hazardous waste as defined by RCRA. However, RCRA has been identified as relevant and appropriate for the incineration portion of the remediation. In particular, a trial burn will be performed and the technical performance requirements of RCRA Subpart O will be met. Additional relevant and appropriate RCRA requirements may be identified as more detailed components of the incineration are evaluated during the remedial design.

Under existing RCRA regulations, hazardous waste incinerators must achieve a destruction and removal efficiency (DRE) of 99.99 percent of organic compounds and comply with emissions limits for particulate matter and hydrogen chloride. These performance standards are primarily technology-based and are supported by data indicating that most hazardous waste incinerators can meet these standards.

40 CFR 264 lists the standards for new facilities which treat, store, or dispose hazardous waste. Subpart O is relevant and appropriate. Table 5 includes specific portions of Subpart O which are ARARs for the rotary kiln incineration portion of the OUI remediation.

7.3.1.3 To-Be-Considered Federal Guidance

CERCLA 40 CFR 300.400(g)(3) classifies standards or guidance which are not applicable or relevant and appropriate as to-be considered (TBC) guidance. The preamble to the NCP states that TBC documents should be used on an "as appropriate" basis. Some examples of TBC documents which may affect the required performance standards of the on-site incinerator are listed in Table 6.

7.3.2 Nebraska ARARs

One state ARAR, Nebraska Air Pollution Control Regulations-Title 129, has been identified as an ARAR for the rotary kiln incineration portion of the OUI remediation. Applicable chapters are summarized in Table 5. Substantive requirements of Title 129 that the rotary kiln incinerator must meet include:

TABLE 6
TO-BE-CONSIDERED GUIDANCE DOCUMENTS
POTENTIALLY AFFECTING INCINERATION

USEPA RCRA Guidance Documents	
A.	Alternate Concentration Limits (ACL) Guidance (draft); Part 1 - Policy & Information Requirements; NTIS PB87-206165. Part 2 - Case Studies (based on 264.94B Criteria) NTIS PB88-214267.
B.	EPA's RCRA Design Guidelines.
C.	Permitting Guidance Manuals:
(1)	Permit Applicant's Guidance for the General Facility Standards of 40 CFR Part 264; NTIS PB87-151064.
(2)	Waste Analysis Plan: A Guidance Manual; NTIS PB87-152112.
(3)	Model Permit Application for Existing Incinerators.
(4)	Guidance Manual for Evaluating Permit Applications for the Operation of Hazardous Waste Incinerator Units.
(5)	Methods Manual for Compliance with BIF Regulations; NTIS PB91-120006.
(6)	Guideline on Air Quality Modeling - Supplements A & B; EPA/450/2-78-027R.
(7)	Quality Assurance/Quality Control (QA/QC) Procedures for Hazardous Waste Incinerators; EPA/625/6-89/023.
(8)	Guidance Manual of Hazardous Waste Incinerator Permits, Volume I of the EPA Hazardous Waste Incineration Guidance Series; NTIS PB86-100-577.
(9)	Guidance on Setting Permit Conditions and Reporting Trial Burn Results, Volume II of the EPA Hazardous Waste Incineration Guidance Series; EPA/625/6-89/019.
(10)	Hazardous Waste Incineration Measurement Guidance Manual, Volume III of the EPA Hazardous Waste Incineration Guidance Series; NTIS PB90-182759 or EPA/625/6-89/021.
(11)	Guidance on Metals and Hydrogen Chloride for Hazardous Waste Incinerators (under review), Volume IV of the EPA Hazardous Waste Incineration Guidance Series; NTIS F-89-BBSP-F-008.
(12)	Guidance on PIC Controls for Hazardous Waste Incinerators (under review) Volume V of the EPA Hazardous Waste Incineration Guidance Series; NTIS F-89-BBSP-F-0009.
(13)	Proposed Methods for Measurement of CO, O ₂ , THC, HCl, and Metals at Hazardous Waste Incinerators, Volume VI of the EPA Hazardous Waste Incineration Guidance Series; NTIS F-89-BBSP-F-0091.
(14)	Permit Writer's Guide to Test Burn Data from Hazardous Waste Incinerators; EPA/625/6-89/012.

- Ambient air quality standards for particulate matter, sulfur, nitrogen dioxide, carbon monoxide, ozone, and lead.
- Emissions limits.
- Proper stack height design.
- Prevent significant deterioration of air quality.
- Limit visible dust generation.

7.4 RESIDUALS MANAGEMENT

This section summarizes an analysis of ARARs affecting the residuals management portion of the OU1 remediation. Residuals which were included in the analysis are liquids from equipment decontamination, residual process water from the air pollution control equipment (e.g. scrubber water), fly ash from air pollution control equipment, treated soil (kiln ash), stormwater, and run-on/runoff water. It is assumed for the purposes of the PDTs, that the treated soil will be sampled and analyzed to show that remediation goals have been met, mixed with other soil to sustain vegetation, and returned to the excavations. The two solid residual streams may be sampled separately or as a single stream. The scrubber water may be used to quench the treated soil. The volume of scrubber water, therefore, is expected to be relatively insignificant. Pertinent ARARs are summarized in Table 7.

7.4.1 Federal Regulations

The following federal environmental regulations have been identified as potential ARARs for the residuals management portion of the remedial action:

- Clean Water Act (CWA).
- Safe Drinking Water Act (SDWA).
- Resource Conservation and Recovery Act (RCRA).

The following sections discuss these regulations and their pertinence to this portion of the remediation.

7.4.1.1 Clean Water Act

The primary purpose of the CWA, also known as the Federal Water Pollution Control Act, is to restore and maintain the quality of surface waters.

The CWA is applicable to disposal of liquid residuals. Residual water from thermal treatment and fluids from equipment decontamination may be discharged to the surface or to surface water. Any on-site discharge must meet the substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit. If treatment is required prior to on-site discharge, liquids may be treated in an on-site treatment facility or they may be treated at an off-site commercial facility. Substantive requirements of a stormwater NPDES permit are also pertinent. TBC guidance includes Guidance Manual for the Preparation of NPDES Permit Applications for Stormwater Discharges Associated with Industrial Activity (EPA, 1991).

TABLE 7
ARARS WITH SUBSTANTIVE REQUIREMENTS FOR RESIDUALS MANAGEMENT

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
FEDERAL					
Clean Water Act (CWA) of 1977, as amended [33 U.S.C. 1251]					
40 CFR 122 - The National Pollutant Discharge Elimination System (NPDES)	40 CFR 122.1-7	Definitions and General Program Requirements	Action	Liquid Residuals Management	Discusses purpose and scope, definitions, exclusions from NPDES permitting, prohibitions, permits, continuation of expiring permits, and confidentiality.
	40 CFR 122.21,22,28,29	Permit Application and Special NPDES Program Requirements	Action	Liquid Residuals Management	Specifies scope and details of NPDES permit applications
	40 CFR 122.41-48	Permit Conditions	Action	Liquid Residuals Management	Establishes limitations, standards, and other permit conditions applicable to all permits, including calculation of standards, permit duration, and compliance schedules. Specifies requirements for recording and reporting of monitoring results.
	40 CFR 122.49	Considerations Under Federal Law	Action	Liquid Residuals Management	When applicable, the Wild and Scenic Rivers Act, National Historic Preservation Act, Endangered Species Act, Coastal Zone Management Act, Fish and Wildlife Coordination Act, and any executive orders will be complied with.
40 CFR 125 - Criteria and Standards for the National Pollutant Discharge Elimination System	40 CFR 125.1-3	Criteria and Standards for Imposing Technology-Based Treatment Requirements	Chemical	Liquid Residuals Management	Establishes purpose, scope, definitions, and criteria for determining standards for technology-based requirements
	40 CFR 125.30-32	Criteria and Standards for Determining Fundamentally Different Factors	Chemical	Liquid Residuals Management	Describes criteria and standards for establishing whether effluent limitations differing from CWA national limits should be imposed. These may be established if factors relating to the discharge are fundamentally different from those considered in promulgating national limits.

TABLE 7 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR RESIDUALS MANAGEMENT

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
CWA (Cont)	40 CFR 125.70-73	Criteria for Determining Alternative Effluent Limitations	Action	Liquid Residuals Management	Establishes criteria for determining alternative effluent limits (as described in 40 CFR 125.30-32), especially for controlling thermal discharge.
	40 CFR 125.100-104	Criteria and Standards for Best Management Practices	Action	Liquid Residuals Management	Best management practices (BMPs) shall be specified to establish specific objectives for control of toxic and hazardous pollutants. BMPs may reflect requirements for spill prevention control and countermeasures plans.
40 CFR 136 - Guidelines Establishing Test Procedures for the Analysis of Pollutants	40 CFR 136.1-5, Appendices A-C	Analytical Procedures for NPDES Applications and Reports	Action	Liquid Residuals Management	Specified methods will be used.
40 CFR 403 - General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403.1-7	Purpose, applicability, objectives, definitions, prohibited discharges, categorical standards, and removal credits.	Chemical	Liquid Residuals Management	Pretreatment standards as promulgated by a POTW will be adhered to, if a discharge to POTW occurs. If fundamentally different factors (as defined in 40 CFR 125.30-32) exist, a variance will be prepared.
Public Health Service Act: Title XIV, as amended by the Safe Drinking Water Act of 1988 [42 U.S.C. 300(f)]					
40 CFR 141 - National Primary Drinking Water Regulations	40 CFR 141.11, 12,50,51	Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs)	Chemical	Liquid Residuals Management	MCLs and MCLGs for organic and inorganic chemicals may be required to be met if wastewater may reach drinking water sources.
	40 CFR 141.60-63	Revised Primary Drinking Water Regulations	Chemical	Liquid Residuals Management	Revised MCLs and MCLGs for organic and inorganic chemicals, sets best available technology for some organics. If these organics are found in wastewater that may reach drinking water sources, BAT will be applied.
40 CFR 143 - National Secondary Drinking Water Regulations	40 CFR 143.3	Secondary MCLs	Chemical	Liquid Residuals Management	Secondary MCLs, which affect mostly aesthetic qualities of drinking water, may be required to be met if wastewater may reach drinking water sources.

TABLE 7 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR RESIDUALS MANAGEMENT

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
Solid Waste Disposal Act (SWDA) as amended by Resource Conservation and Recovery Act (RCRA) of 1976 [42 U.S.C. 6901]					
40 CFR 261 - Identification and Listing of Hazardous Wastes	40 CFR 261.1-7,10, 11,20-24,30-33	Definition of Solid and Hazardous Wastes	Chemical	Solid Residuals Management	RCRA regulations are not applicable, but relevant and appropriate, as OUI soil is not defined as a hazardous waste. However, solid treatment residuals will require testing by the toxicity characteristic leaching procedure to determine if they are hazardous.
40 CFR 268 - Land Disposal Restrictions	40 CFR 268.30-37	Waste Specific Prohibitions	Chemical	Solid and Liquid Residuals Management	No liquid wastes will be disposed of on land. If any of the waste codes listed in these sections are found, they will not be disposed of on land.
	40 CFR 268.40-43	Treatment Standards	Chemical	Solid and Liquid Residuals Management	If wastes subject to 40 CFR 268.30-37 are found, treatment as specified in these sections will be applied.
	40 CFR 268-45	Treatment Standards for Hazardous Debris	Chemical	Solid Residuals Management	If debris is found to be hazardous, it will be treated such that it is no longer contaminated with hazardous waste.
STATE					
Nebraska Environmental Protection Act					
Nebraska Water Quality Standards	Title 117 Chapters 2-4	Surface Water Quality Standards	Chemical	Liquid Residuals Management	Ambient water quality standards for protection of aquatic life, a level of 0.230 mg/l has been set for 2,4-DNT.
Nebraska Groundwater Quality Standards	Title 118 Chapters 2-4	Applicability, Antidegradation, and Standards	Chemical	Liquid Residuals Management	Wastes shall not be discharged to groundwater if beneficial uses of the groundwater or hydrologically connected groundwater is impaired. MCLs are also given for organic and inorganic chemicals for discharge to groundwater
	Title 118 Chapters 6-8	Groundwater Beneficial Uses, Classification, and Procedures for Changing Classification	Location	Liquid Residuals Management	Groundwater in the area is classified as GB. Beneficial uses include: private drinking water supply, irrigation, and livestock watering.
Nebraska NPDES Permit Regulations	Title 119	General Program Requirements	Action	Liquid Residuals Management	If wastewaters are to be discharged, monitoring requirements shall be followed.

TABLE 7 (Continued)

ARARS WITH SUBSTANTIVE REQUIREMENTS FOR RESIDUALS MANAGEMENT

Laws	Rules and Regulations	Description	Classification	Affected Portion of Remedy	Substantive Requirements
Nebraska General NPDES Rules for New and Existing Sources	Title 121 Chapters 2,8	Effluent Standards and Test Methods	Chemical	Liquid Residuals Management	For explosives load, pack and assemble facilities, 1-day maximum effluent limits: O&G - 0.11 lb/1,000 lb, TSS - 0.26 lb/1,000 lb, pH 6-9. 30-day maximum averages: O&G - 0.035 lb/1,000 lb, TSS - 0.088 lb/1,000 lb, pH 6-9.
Nebraska Pretreatment Regulations	Title 127 Chapters 2-5	Describes Categorical Pretreatment Standards, Prohibited Discharges, and Effluent Limitations	Chemical	Liquid Residuals Management	If wastewaters are to be discharged to a POTW, prohibitions and limitations shall be followed.
	Title 127 Chapters 6-38	Details on Permit Application and Compliance Report	Action	Liquid Residuals Management	If wastewater are to be discharged to a POTW, compliance reports shall be completed.
Nebraska Hazardous Waste Rules	Title 128 Chapters 4, 9-15	Definitions of Solid and Hazardous Waste	Action	Solid Residuals Management	Relevant and appropriate, but not applicable, because OUI soil is not determined to be a hazardous waste.

Under 40 CFR 125, Subpart K, presents substantive requirements that may be imposed onto on-site operations. 40 CFR 125.102 specifies "materials storage areas, in-plant transfer, process and material handling areas, loading and unloading operations, plant site runoff, and sludge and waste disposal area," as ancillary activities for which best management practices (BMPs) must be used. These are applicable to the excavation, materials handling, and site work at the former NOP site. BMPs, however, are not specified in this regulation. This regulation notes that additional technical information on BMPs and the elements of the BMP program are contained in the document: NPDES Best Management Practices Guidance Document.

7.4.1.2 Safe Drinking Water Act

The purpose of the SDWA is to protect and maintain United States drinking water sources. This regulation is an ARAR for liquid residuals which may be discharged to the surface where it can percolate into groundwater. The SDWA specifies maximum contaminant levels (MCLs) and MCL goals for inorganic and organic chemicals and microbiological contaminants. Explosive compounds are not regulated; therefore this regulation is not applicable. Due to the chemical nature of explosives, however, there is a potential for nitrate in the discharge. Nitrate is included in the SDWA. Because private use of groundwater at the site is not precluded, this regulation is relevant and appropriate to liquids discharge.

7.4.1.3 Resource Conservation and Recovery Act

RCRA is applicable to the solid treatment residuals. Treated soil and fly ash must pass the Toxicity Characteristic Leaching Procedure prior to blending to sustain vegetation and placing back in excavations.

7.4.2 State ARARs

State ARARs identified as pertinent to residuals disposal include the following:

- Water Quality Standards for Surface Waters of the State- Title 117
- Groundwater Quality Standards and Use Classification- Title 118
- Rules and Regulations Pertaining to the Issuance of Permits under the NPDES System - Title 119
- Nebraska General NPDES Rules for New and Existing Sources: Effluent Guidelines and Standards - Title 121
- Rules and Regulations Governing the Nebraska Pretreatment Program- Title 127
- Rules and Regulations Governing Hazardous Waste Management in Nebraska- Title 128

Pertinent chapters of these regulations are listed in Table 7. The following subsections discuss substantive requirements of these ARARs.

7.4.2.1 Nebraska Water Quality Standards - Title 117

This regulation defines beneficial uses of surface waters of the state (such as public water supply, irrigation, recreation, aquatic life support). Surface waters are grouped into river basins, and ambient water quality criteria are set for the different beneficial uses. One of the contaminants found in NOP OU1 soils, 2,4-Dinitrotoluene, has had an ambient water quality standard of 0.230 mg/L set for aquatic life.

7.4.2.2 Nebraska Groundwater Quality Standards - Title 118

This regulation is intended to be the basis for state groundwater regulatory programs. Numerical standards (maximum contaminant limits, or MCLs) are given for a number of substances. The regulation states that no wastes shall be discharged to groundwater if beneficial uses of groundwater or hydrogeologically connected groundwater is impaired. Groundwater classifications are also contained in this statute. In the NOP area, the classification is GB. Beneficial uses of this classification include: private drinking water supply, irrigation, and livestock watering.

7.4.2.3 Nebraska NPDES Permit Regulations - Title 119

This statute outlines general program requirements for the state NPDES program. It is applicable if wastewaters are discharged to surface waters or to a publicly-owned treatment works (POTW).

7.4.2.4 Nebraska General NPDES Rules for New and Existing Sources - Title 121

This regulation gives details of the state NPDES program. Effluent standards and test methods are included. A section of the Clean Water Act is incorporated by reference, and is relevant and appropriate to OU1 remedial activities. Under the section entitled "Explosives Load, Assemble, and Pack Plants Category", 1-day maxima for oil and grease (O&G) of 0.1 lb/1,000 lb, and total suspended solids (TSS) of 0.26 lb/1,000 lb are given. pH must be in the range of 6.0 to 9.0. 30-day averages of O&G and TSS shall not exceed 0.035 lb/1,000 lb and 0.088 lb/1,000 lb, respectively.

7.4.2.5 Nebraska Pretreatment Regulations - Title 127

These regulations pertain to discharge of effluent to a POTW, and will be applicable if wastewaters from remedial activities are released to a POTW. Certain prohibitions and limitations on POTW discharge are given in the regulation, and must be followed. In addition, testing and compliance reports must be completed if discharge is to a POTW.

7.4.2.6 Nebraska Hazardous Waste Rules - Title 128

This regulation defines solid hazardous wastes. It will be applicable to solid residuals, as treated soil and fly ash will require TCLP testing to determine if it must be treated as a hazardous waste.

8.0 DESIGN ISSUES TO BE RESOLVED

The following issues will have some impact on how all phases of the remedial design proceeds:

- Addressing OU 2 soil under the OU 1 remedial action will change the strategy of the predesign investigation, influent loading, spatial requirements, unit size, duration, and cost.
- If debris regulations require further characterization of the debris during the predesign investigation, it will change the scope of the predesign investigation.
- Space requirements will have to be negotiated with the University.
- The impact of processing and excavation/hauling on University activities will have to be identified and negotiated with the University.
- The utility requirements will be compared with current availability of utilities at the site and a plan will be developed to meet the needs of the remediation.
- The substantive details of ARARs will impact options for process/decontamination water and wastewater.
- Road restrictions on local highways will affect the transport of equipment or materials to the site if they exist.
- Available landfill facilities for oversize material and debris will impact off-site hauling and disposal costs.
- A determination must be made for which components of the remediation require performance evaluations, what parameters will be tested, and what criteria will be acceptable for those parameters.
- The substantive implications of ARARs will impact the performance criteria of the remedy.
- Need to determine what Army safety approvals have to be met for design.
- Need to determine what, if any, safety precautions have to be included for excavation and processing.

9.0 HEALTH AND SAFETY CONSIDERATIONS

Potential risks to remedial action workers and the community include potential emissions from excavation, materials handling, construction, and transportation activities, in addition to those which may result from thermal treatment. Fugitive dust emissions from these activities will be controlled as needed by spraying a dust suppressant over excavation and transportation areas, staging the soil under plastic sheeting, and enclosing soil in a temporary building during pretreatment. Truck beds will be covered during transportation of material from excavation sites to the staging and preprocessing areas. These control measures will minimize the quantity of contaminated soil that may become airborne, and thus reduce fugitive emissions. This will minimize potential inhalation, ingestion, and direct contact risks from particulates to workers and to nearby residents.

Buried, unexploded ordnance and explosive wastes (OEW) may also pose a potential risk to workers, especially during excavation. Specialized construction techniques (which may include misting, blast shields, and sparkless tools) may be used to mitigate this risk if needed.

Construction activities will cause an increase in noise and traffic. Due to the relatively isolated location of the site, this increase is not expected to present a significant problem for the surrounding community.

Thermal treatment emissions will be minimized by using appropriate air pollution control equipment. Such equipment may include afterburners, cyclones, baghouse filters, and scrubbers. Incinerator emissions were evaluated using Tier analyses and are included in Section 11.0. In addition to emissions, high-temperature activities may pose a risk to on-site workers. A hazard analysis will be completed for the components of the remedy and the equipment used.

A health and safety plan will be prepared by the remedial action contractor, which will address the following:

- Applicable regulatory requirements.
- Personnel responsibilities.
- Procedures and protocols.
- Decontamination.
- Training.
- Emergency contingencies.
- Medical surveillance.

The plan will identify problems and hazards that may be encountered, and their solutions. Procedures for protecting third parties, such as visitors or the surrounding community, will also be provided. The plan will also discuss safe work procedures for handling of the contaminated soil and use of high-temperature equipment.

10.0 OTHER CONCERNS

10.1 COMMUNITY RELATIONS ACTIVITIES

The Community Relations Plan (SEC Donohue, 1992) prepared under the RI/FS for OU 1 includes parties that expressed interest in the site. The Community Relations Plan is available in the information repository. An updated Community Relations Plan may be necessary to address community concerns in advance of the design and construction of a selected remedy. The need for Community Relations Plan updates will be determined by USACE.

11.0 TIER ANALYSIS

11.1 PURPOSE AND ASSUMPTIONS

A tier analysis is being conducted for this Predesign Technical Summary to begin to identify parameters of the incineration system. The tier analysis identifies metals and other elements in the feed which could limit feed rates due to the potential to exceed allowable emission rates. The following are the results from a preliminary study of the application of Tier I and Tier II analyses from the Boiler and Industrial Furnace (BIF) regulations (40 CFR 266.100) and how they would effect the production rate of a theoretical incineration system installed at the former NOP site.

Data utilized for the preliminary tier analysis consisted of the specific laboratory analysis from the different areas around the facility (RUST, 1993; SEC Donohue, 1992b). All values were given in mg contaminant/kg soil. The basis of the analysis is as follows:

- Quantity of material to be processed is 8400 yds³.
- All processing to be completed in 1 year (350 days at 24 hours per day).
- All soil exhibits consistent density and moisture as shown in the treatability study.
- No chlorinated hydrocarbons in the soil material (less than 0.1 percent by weight).
- Contaminants as shown in the laboratory analysis.
- Rotary kiln style incineration with air pollution control (APC).

11.2 TIER ANALYSIS

The tier analysis is the process of analyzing the contaminants in the waste or soils and determining the allowable production rate so emissions are below regulatory limits. The Boiler and Industrial Furnace regulations give four basic levels of tier analysis, with each level allowing higher feed rates of contaminants, but requiring corresponding higher levels of emission characterization.

Tier I assumes all feed contaminants are emitted out the stack. This tier then limits the feed rate by limiting the rate of contaminant feed. Tier II allows higher feed rates by allowing accounting for removal of contaminants for known processes and APC systems. Tier III allows the maximum feed rate of contaminants, however, it also requires site-specific air modeling and health risk assessment to characterize the emission levels. Adjusted Tier I also requires site-specific air modeling data but is simpler than Tier III utilizing some default terrain and dispersion assumptions.

For the purpose of this evaluation, only Tiers I and II were considered. From this data, it is possible to get an indication of the expected emission levels and the basis for any approach to the final tier analysis work.

11.2.1 Tier I Analysis of Soil Feed

The 10 hazardous metals in which the screening limits published in Appendix I to Part 266, Table 1-B were checked against the estimated feed rates. The BIF regulations assume that the effects of the four hazardous metals listed as carcinogenic (arsenic, cadmium, chromium, and beryllium) are cumulative and must be calculated as a ratio of the screening limit. These ratios are added and cannot be greater than 1.

The basis for operations is processing time of one year. However, based on the Treatability Study, only a 50 percent line time is assumed. Processing duration was considered to be 350 days and 24 hr/day operation. Therefore, the processing rate for 8,400 yd³ of soil at approximately 97 lbs/ft³ is 4730.4 lbs/hr or 2146 kg/hr. From this feed rate, the emission rates were calculated based on the analytical data. The highest area average concentration was to be used for analysis purposes, regardless of the quantity of soil to be treated (Scope of Work, Section (3a)). Therefore, the data from LL1 and BPG were combined to give data for all the metals under consideration. The areas were combined since LL1 had the highest averages for the four metals analyzed, however, only the BPG had analysis for all metals. It should be noted that all the detected concentrations were above the MDL. Table 8 shows the contamination levels used for analysis and the metals loading based on a 2146 kg/hr feed rate.

For the tier analysis, assumptions were a flat terrain, not rising to over 4 meters higher than the stack base level, and a rural population (less than 30 percent urban usage). Also, a 100-foot system exhaust stack height is the basis of design. This stack height is typical of a small incineration unit. This resulted in a terrain adjusted effective stack height (TAESH) of approximately 26 meters. The BIF regulations give Tier I and II feed and emission rate for this TAESH as part of 40 CFR Part 266, Appendix I. Comparison with the feed rates expected from Table 8 determines if an individual constituent will meet the Tier I screening limits. Table 9 gives the screening limits and Tier I status.

11.2.2 Tier II Analysis

Because the screening limits have been exceeded, the next alternative would be to go to a Tier II level. Although the emission limits are the same as the emission limits for Tier I, in the Tier II analysis, the regulations allow for removal by the installed air pollution control devices. The system removal efficiencies (SREs) are dependent upon the constituent being removed, the temperature, and the APC System technology. Because the regulations allow application of the Tier analysis to individual components, and since lead, arsenic, and chromium have failed the Tier I criteria, then the criteria for Tier II analysis will be applied to these constituents only. In Tier II partitioning of metals in the air pollution control system (APCS), the BIF regulations provide conservative partitioning data in the Methods Manual for Compliance with the BIF Regulation 40 CFR Part 266 Appendix IX, EPA 530-SW-91-010. The BIF regulations, however, do not provide partitioning for metals in incinerator soils or ash. To represent reality in the analysis, partitioning must be considered for the ash discharge from the rotary kiln primary

TABLE 8
DETECTED CONTAMINANT LEVELS

Constituent	Area	Detected Level (mg/kg)	Resulting Loading Rate (g/hr)
NONCARCINOGENIC			
Antimony	BPG	3.49	7.49
Barium	LL1	284.08	609
Lead	LL1	40.60	87.13
Mercury	BPG	0.128	0.275
Silver	BPG	2.89	6.202
Thallium	BPG	0.146	0.313
CARCINOGENIC			
Arsenic	LL1	5.85	12.55
Cadmium	BPG	0.798	1.69
Chromium	LL1	25.46	54.6
Beryllium	BPG	0.896	1.62

TABLE 9
TIER 1 COMPARISONS

Constituent	Estimated Emission Rate (g/hr)	Tier I Screening Limit (g/hr)	Tier I Status (Pass/Fail)
NONCARCINOGENIC			
Antimony	7.49	280	Pass
Barium	609	46000	Pass
Lead	87.13	82	Fail
Mercury	0.275	280	Pass
Silver	6.202	2800	Pass
Thallium	0.313	280	Pass
CARCINOGENIC			
Arsenic	12.55	2.1	Fail
Cadmium	1.69	5.0	Pass
Chromium	54.6	0.76	Fail
Beryllium	1.62	3.9	Pass

chamber. Guidance is offered in Volume IV of the Hazardous Waste Incineration Guidance Series, Guidance on Metals and Hydrogen Chloride Control for Hazardous Waste Incinerators, August 1989 EPA 1530-SW-90-00.

For partitioning metals in the incinerator primary chamber ash, the Incineration guidance document offers partition factors for each of the 10 metals, depending on solids temperature and chlorine content. As indicated in the treatability study, the target temperature is 1600°F and there are little or no chlorinated contaminants in the waste. For this combination, the guidance document indicates 100 percent of Lead, 100 percent of Arsenic, and 5 percent of chromium is partitioned to the incinerator APCS.

For partitioning of metals in the air pollution control system (APCS), the Incineration Guidance document as well as the BIF regulations offer slightly varied approaches to the APCS removal efficiency. The Incineration guidance document gives Removal Efficiencies (REs) for individual metals for each air pollution technology combination. The BIF regulations classify metals as volatile or very volatile, depending on the APCS process temperature, chlorine content of the waste, and system thermal input, then group all metals under these two categories to determine APCS REs. For this analysis, the BIF removal efficiencies are used, providing a more conservative emission rate.

Since laboratory analysis indicates there is less than 0.1 percent chlorinated wastes present in the feed stock, the temperatures at which the metals are considered very volatile can be found in reference tables in the BIF Methods Manual. For lead, the temperature varies between 1280°F to 1000°F, classifying Lead as a volatile metal. For chromium, the temperatures vary between 2000°F and 1500°F, also classifying in the volatile category. For arsenic, the temperatures vary between 320°F and 240°F. This makes it more difficult to classify Arsenic as volatile or very volatile, since this is the temperature range which baghouses typically operate. Based on recent publications and performance of existing remedial incinerators, Arsenic has shown high ash partitioning and APCS RE data. Therefore in this analysis, Arsenic will be considered volatile and the BIF efficiency of 90 percent for volatile metals will be used.

For this analysis a single stage spray dryer/fabric filter combination will be used as the APC train. The spray dryer acts as the quench, with the fabric filter acting as the particulate removal device. For lead, arsenic, and chromium, the 90% RE for this APC combination is used. The resulting emission rates are as follows:

Lead:

$$87.13 \frac{\text{g}}{\text{hr}} \times 0.10(\text{APCS RE}) = 8.7 \frac{\text{g}}{\text{hr}}$$

Arsenic:

$$12.55 \frac{g}{hr} \times .10(APCS\ RE) = 1.26 \frac{g}{hr}$$

Chromium:

$$54.6 \frac{g}{hr} \times 0.05(Ash\ Partition) \times 0.10(APCS\ RE) = .27 \frac{g}{hr}$$

Table 10 shows a comparison of the estimated emission rates against the Tier II screening limits. Lead, arsenic, and chromium pass the respective Tier II Emission Limits.

Since Carcinogenic metals are considered cumulative from a health risk basis, the sum of the ratio of the four carcinogenic metals relative to the screening limits must be less than one.

$$\sum \left(\frac{Emission\ rate}{Tier\ Screening\ Limit} \right) < 1.0$$

Arsenic:	1.26 g/hr / 2.1 g/hr = 0.6
Cadmium:	1.69 g/hr / 5.0 g/hr = .34
Chromium:	0.27 g/hr / 0.76 g/hr = .36
Beryllium:	1.62 g/hr / 3.9 g/hr = .42

Sum Totals of all Metals: 1.72 > 1.0

Because the cumulative ratios of all metals are too high, Tier II analysis will be performed on cadmium and beryllium, allowing ash partitioning and APCS removal.

Utilizing the same basis for Tier II analysis as above, ash partitioning for cadmium is 100 percent to the APCS. For beryllium 95 percent is partitioned to the ash and 5 percent to the APCS. APCS partitioning per the BIF guidance document indicates both metals are volatile and a removal efficiency in the APCS of 90 percent. Using these partitioning and removal efficiencies, the emission rates for cadmium and beryllium are as follows:

Beryllium:

$$1.62 \frac{g}{hr} \times (Ash\ Partition) \times 0.10(APCS\ RE) = .0081 \frac{g}{hr}$$

Cadmium:

$$1.69 \frac{g}{hr} \times 0.10(APCS\ RE) = 0.169 \frac{g}{hr}$$

TABLE 10
TIER II ESTIMATED EMISSION RATE

Metal Constituent	Estimated Emission Rate with 90% Removal (g/hr)	Tier II Screening Limit (g/hr)
Lead	8.7	82
Arsenic	1.26	2.1
Chromium	0.27	0.76

As before, summing the ratios of the carcinogenic metals is as shown below:

Arsenic:	$1.26 \text{ g/hr} / 2.1 \text{ g/hr} = 0.6$
Cadmium:	$0.17 \text{ g/hr} / 5.0 \text{ g/hr} = 0.03$
Chromium:	$0.27 \text{ g/hr} / 0.76 \text{ g/hr} = 0.36$
Beryllium:	$0.0081 \text{ g/hr} / 3.9 \text{ g/hr} = 0.002$

Sum Totals of all Metals: $0.99 < 1.0$

Based on the sum of the ratios above, carcinogenic metals fall within the guidelines for emissions.

11.2.3 Other Emissions

The BIF regulations also regulate particulate matter and chlorine emissions. Because no chlorinated waste is present, the screening limits should not be a problem. However, particulate matter must be addressed. Particulate matter (PM) emissions are estimated using grain loading into the APC system and estimated APC SREs. The default values for particulate matter removal are given in the BIF regulations. At this time, the current regulated emission standard is 0.08 gr/dscf corrected to 7 percent O₂. However, EPA guidance and recent incinerator permits and applications indicate that USEPA is pushing for a 0.015 gr/dscf corrected to 7 percent O₂ emission limit. With a good APC system design, particulate matter is generally not considered to be a problem, however, the metal emissions must be considered as part of the particulate matter and added to estimate the total PM emissions rate.

11.2.4 Conclusion

The tier analysis indicates that, utilizing Tiers I and II approach, emissions fall within the screening and emission limit guidelines indicated in the BIF regulation. The basis for design was very conservative, using only one style of APCS device. Additionally, the BIF regulations are very conservative in relation to APCS removal efficiencies. If the incinerator guidance is used for tier analysis, higher APCS removal efficiencies will be utilized. Also current operating sites have shown high partitioning ratios of carcinogenic metals.

Although only Tier I and II have been applied above, the location of the incineration system may dictate a Tier III style of analysis. Placement of the incineration system in the areas of the tall buildings or given the fact that the unit is a hazardous waste incineration system, a detailed air model and risk assessment may be required by the regulatory agencies. While this does not indicate emission problems, there will be more up front work than just a Tier I and II analysis.

When the incineration unit is selected, the design will then dictate the exact conditions for emission analysis. Once this analysis is completed, trial burns will verify the system performance.

12.0 REFERENCES

- RUST Environment & Infrastructure (RUST) (1993), Draft Treatability Study Report, Former Nebraska Ordnance Plant, Operable Unit 1, Mead, Nebraska.
- SEC Donohue (1992a), Draft Final Community Relations Plan, Former Nebraska Ordnance Plant, Mead, Nebraska, May 28, 1992.
- SEC Donohue (1992b), Supplemental Remedial Investigation Report, Former Nebraska Ordnance Plant, Operable Unit 1, Mead, Nebraska.
- U.S. Army Corps of Engineers (USACE) (1989), Confirmation Study, Former Nebraska Ordnance Plant, Mead, Nebraska. USACE, Kansas City District.
- USACE (1991), Draft Remedial Investigation Report, Operable Unit 1, Former Nebraska Ordnance Plant, Mead, Nebraska. USACE, Kansas City District.
- U.S. Environmental Protection Agency (USEPA) (1993), Personal Communication with Greg McCabe.
- USEPA (1989), Guidance on Metals and Hydrogen Chloride Control for Hazardous Waste Incinerators. EPA 1530-SW-90-00.
- USEPA, Methods Manual for Compliance with the BIF Regulation, 40 CFR Part 266 Appendix IX, EPA 530-SW-91-010.
- USEPA (1992), Technical Implementation Document for EPA's Boiler and Industrial Furnace Regulations. EPA-530-R-92-011.
- U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) (1987), Testing to Determine Relationship Between Explosive Contaminated Sludge Components and Reactivity. Report No. AMXTH-TE-CR-86096.

APPENDIX A

PREDESIGN INVESTIGATION
SAMPLING STRATEGY

MEMORANDUM

DATE: May 25, 1994

TO: Natalee Tillman - USACE
NOP Files

FROM: Chandler Taylor - RUST
Sarah Levin - RUST
Karen Miller - RUST

SUBJECT: Soil Sample Locations for OU 1 Predesign Field Investigation

Sample locations for the OU 1 predesign field investigation were determined assuming that the purpose of the investigation is only to further define the horizontal extent of contamination based on OU 1 remediation goals (RGs). Therefore, all sample depths will be 4 feet deep or shallower. The sample locations were chosen to:

1. Verify field screen data above RGs (where no laboratory sample was collected) in areas where explosives contamination may exist. Field data will not be verified in areas where there is no evident source of contamination (e.g. positive grid points in farm fields where no loading/assembling activities are known to have occurred) and where nearby lab data are below RGs.
2. Further define the source areas previously delineated using the OU 1 RGs.

Based on the OU 1 RGs, the estimated number of sample locations that will be required to define the horizontal extent of contamination are listed below:

	<u>Total Locations*</u>
Bomb Booster Area	3
Load Line 1	10
Load Line 2	4
Load Line 3	8
Load Line 4	1
Burning/Proving Ground	13 **
Total	39

* Two sample points per location (see specific assumptions below).

** Includes soil samples and test pits in the disposal trenches identified by TCT and aerial photography (see discussion presented below).

These estimated sample numbers are based on the general assumptions discussed above and the specific assumptions outlined below.

1. Positive field screen data will be confirmed with predesign samples if the field screen locations were in areas of suspected contamination (e.g. in sumps, along ditches, and immediately adjacent to ditches previously delineated as source areas).
2. Source areas will be better delineated by predesign samples if source areas were originally delineated using points further than 50 feet apart. This only applies to locations where a ditch segment extends half-way between a sample above RGs and a sample below RGs; it does not include two samples which are both above OU 1 RGs and further than 50 feet apart.
3. Two samples, one at 0 to 2 feet and one at 2 to 4 feet, will be collected at each location. If the 0- to 2-foot sample is above OU 1 RGs, the location will require excavation to 4 feet and the 2- to 4-foot sample will not be analyzed. If the 0 to 2-foot sample is not above OU 1 RGs, the 2- to 4-foot sample will be analyzed to determine if it is above the OU 1 RGs. If it is above OU 1 RGs, then the area must be remediated.

FIELD SCREENS

Due to the false positive problems experienced during the RI, we do not believe that it would be worthwhile to employ the same field screen methods for the predesign. New field screen methods (e.g., immunoassay), however, have been developed since the RI. These methods may be beneficial during construction to limit the number of laboratory samples used to confirm the extent of excavation and degree of treatment if they are capable of detecting explosives compounds of concern for the NOP soil and if they are accurate and reliable. RUST currently does not have the information to properly evaluate new field screen methods and is not scoped to do so under Tasks 1 and 2. Therefore, an evaluation of field screen methods will be built into the Work Plans as a prefield component, and one or more field screen methods will be used for all samples in the field to establish a correlation between lab and field data. Correlation results will be used to help justify use of field screen methods during construction.

BURNING/PROVING GROUND TRENCHES

There does not appear to be information on the disposal trenches in the Burning/Proving Grounds. Test pits are being conducted in the trenches to determine 1) if they contain soil, and 2) if they contain soil above OU 1 RGs. Test pits will be dug to make determination (1) for cross-sections at three points along the length of the trench. If the contents is predominantly material other than soil, a determination will have to be made on how to handle treatment/disposal of the contents. If the trenches do contain predominantly soil, samples will be collected (0 to 2 and 2 to 4-foot intervals) and the trenches will be treated similar to the other areas of the site.

The disposal trenches in the Burning/Proving Grounds need to be further delineated.

Due to the nature of historical activities performed in the Burning/Proving Grounds, UXB (or an equivalent contractor) will be required during any predesign activities carried out in this area (trenching or sampling).

APPENDIX B

JUSTIFICATION OF TNT AS THE PRINCIPAL ORGANIC HAZARDOUS CONSTITUENT

MEMORANDUM

DATE: May 30, 1994

TO: Natalee Tillman - USACE
NOP Project Files

FROM: Chandler Taylor - RUST

SUBJECT: Justification of TNT as the POHC

The justification for using 2,4,6-Trinitrotoluene (TNT) as the Principal Organic Hazardous Constituent (POHC) for the incineration trial burn at the former NOP site is developed based on a similar justification done for the Savanna Army Depot site. The attached memorandum describes the justification conducted by Roy F. Weston, Inc. for Savanna. The following parallels can be drawn for the former NOP site which suggest such a justification is warranted for this site:

- The principal contaminant at the former NOP site is TNT. The highest explosives concentrations at the site are those of TNT. The most commonly detected contaminant at the site is TNT. Samples collected for the treatability studies to simulate the concentrations that the full-scale unit can expect showed roughly three times more TNT than the next highest compound (RDX) (RUST, 1993).
- The concentration of TNT in the treatability study samples was sufficiently high (1200 to 1700 mg/kg) to demonstrate a destruction and removal efficiency of at least 99.99 percent.

Other conclusions in the memorandum regarding compatibility and stability are chemical-dependent rather than site-dependent and will parallel the former NOP site.

W/6/MEAD2/PDTS1/MEMO1



1 WESTON WAY
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PHONE: 215-892-3030
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30 July 1992

David P. Seely, Remedial Project Manager
U.S. Environmental Protection Agency
Mail Code HSRL-6J
77 West Jackson Boulevard
Chicago, IL 60604

Charlene Falco, Project Manager
Illinois Environmental Protection Agency
Division of Land Pollution Control
2200 Churchill Road
Springfield, IL 62706

Work Order No.03886-062-001

Reference: Incineration of Explosives at SADA and AAAP
Contract No. DADA-90-C-0066

Subject: Annotated List of POHC's for SADA Trial Burn

Dear Dave and Charlene:

Per your request, Roy F. Weston, Inc. (WESTON.) has investigated the potential usage of a Principal Hazardous Organic Constituent (POHC) that may be used for spiking soil for Trial Burn conditions. The attached annotated list (Attachment 1) was extracted from the "Guidance on Setting Permit Conditions and Reporting Trial Burn Results" EPA/625/6-89-019, January 1989. The purpose of selecting a POHC is to demonstrate the performance of the transportable incineration system (TIS) using a compound that is sufficiently similar to the principal contaminant of interest.

The principal contaminant at the Savanna Army Depot Activity Washout Lagoon Area is 2,4,6-trinitrotoluene (TNT). WESTON. conducted a random sampling program in July 1992 to evaluate the TNT concentration (using the field screening method) in the material segregated for use during the trial burn. Based on these results (included in Attachment 2) that the concentration of TNT in the stockpiled contaminated soils is sufficiently high (greater than 200 parts per million (ppm)) to demonstrate a destruction and removal efficiency (DRE) of at least 99.99 percent.

However, at the IEPA's request, WESTON has evaluated the list of POHC's for those potential POHCs above the thermal stability ranking of 1,3,5-trinitrobenzene and 2,6-dinitrotoluene (which are similar in structure to TNT). All of the compounds on the list have been eliminated as potential POHCs on the following basis:



David P. Seely, USEPA
Charlene Falco, IEPA

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30 July 1992

- A = Chlorinated, brominated, fluorinated, cyanide- or sulfide-bearing.
- B = Carcinogenic.
- C = Incompatible with TNT as shown on Attachment 3 (i.e., acids; aldehydes; caustics; metals; azo, diazo compounds, hydrazines; esters; nitrides; peroxides, hydroperoxides; phenols, cresols; sulfides; epoxides; combustible and flammable materials; explosives).
- D = Not enough available information (Source List included in Attachment 1); however, sufficiently similar to other carcinogenic compounds listed.
- E = Not commercially available.
- F = Heat of combustion greater than TNT.

Several of the compounds may be ruled-out for more than one of the above reasons, however, only one reason is shown on the table.

As stated in the attached Hazard Component Safety Data sheet (Attachment 4) provided by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA):

"Explosives must be tested for compatibility with any material not specified in the production-procurement package with which they may come in contact. Materials include other explosives, solvents, adhesives, metals, plastics, paints, cleaning compounds, floor and table coverings, packing materials and other similar materials, situations and equipment, explosives include propellants and pyrotechnics."

WESTON. believes that the trial burn program should be conducted using the existing TNT in the soil as the POHC for the following reasons:

- A sufficient volume of explosives-contaminated waste with adequate TNT concentrations is believed to be available for the trial burn from the soil stockpiled on the upper lagoons.
- It is undesirable, when avoidable, to mix other potentially incompatible, combustible, or reactive compounds with explosives-contaminated soil.
- When mixing is required, extensive comparability/stability testing must be performed by a certified/permitted testing facility using the explosives mixture.

WESTON

David P. Seely, USEPA
Charlene Falco, IEPA

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30 July 1992

- The regulation concerning POHCs (40 CFR 264.342) does not prohibit the use of the contaminant existing in the waste feed as the POHC. Further, the regulation states that constituents are more likely to be designated as POHCs if they are present in large quantities or concentrations in the wastes. Although an Appendix VIII constituent may normally be used for a POHC, in this application it is not advisable due to the potential incompatibility with TNT. In addition, the Appendix VIII compounds that are present in the soil are explosive compounds in insignificant concentrations. The chemical structures of the Appendix VIII constituents (explosives) present are sufficiently similar to the structure of TNT. The effectiveness of the TIS to destroy these Appendix VIII constituents will be demonstrated during performance testing of the TIS to thermally destroy TNT.

Following review, please contact me at (215) 344-3445 for discussion. After convergence with IEPA and EPA, WESTON. will evaluate the impacts on the trial burn program with USACE.

Very truly yours,

ROY F. WESTON, INC.



Andrea K. Cohen, P.E.
Project Engineer

AKC:ma

Attachments

cc: Gordon Stevens - USACE
Frank Bales - USACE
Rick Schipp - USACE
John Clarke - SADA
Dianna Feireisel - USATHAMA
Chuck Lechner - USATHAMA

POHC.730/ARC

ATTACHMENT 1
ANNOTATED LIST OF POTENTIAL POHCs

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index

Principal Hazardous Organic Constituent	Rank
CLASS 1	
A CYANOGEN {ETHANEDINITRILE}	1
A HYDROGEN CYANIDE {HYDROCYANIC ACID} [2]	2
A BENZENE [2]	3
A SULFUR HEXAFLUORIDE [3]	4
F NAPHTHALENE [2]	5
F FLUORANTHENE {BENZO[j,k]FLUORENE}	6
F, D BENZO[j]FLUORANTHENE {7,8-BENZOFUORANTHENE}	7
F, D BENZO[b]FLUORANTHENE {2,3-BENZOFUORANTHENE}	8
F, B BENZANTHRACENE (1,2-) {BENZ[a]ANTHRACENE}	9
F, B CHRYSENE {1,2-BENZPHENANTHRENE}	10
F, B BENZO[a]PYRENE {1,2-BENZOPYRENE}	11
F, D DIBENZ[a,h]ANTHRACENE {1,2,5,6-DIBENZANTHRACENE}	12
F, D INDENO(1,2,3-cd)PYRENE {1,10-(1,2-PHENYLENE)PYRENE}	13
F, D DIBENZO[a,h]PYRENE {1,2,5,6-DIBENZOPYRENE}	14
F, D DIBENZO[a,i]PYRENE {1,2,7,8-DIBENZOPYRENE}	15
F, D DIBENZO[a,e]PYRENE {1,2,4,5-DIBENZOPYRENE}	16
A CYANOGEN CHLORIDE {CHLORINE CYANIDE}	17-18
C ACETONITRILE {ETHANENITRILE} [2]	17-18
A CHLOROBENZENE [2]	19
F, B ACRYLONITRILE {2-PROPENENITRILE} [2]	20
A DICHLOROBENZENE {1,4-DICHLOROBENZENE}	21-22
A CHLORONAPHTHALENE (1-) [2]	21-22
A CYANOGEN BROMIDE {BROMINE CYANIDE}	23-24
A DICHLOROBENZENE {1,2-DICHLOROBENZENE} [2]	23-24
A DICHLOROBENZENE {1,3-DICHLOROBENZENE} [2]	25
A TRICHLOROBENZENE (1,3,5-TRICHLOROBENZENE) [2] [4]	26-27
A TRICHLOROBENZENE (1,2,4-TRICHLOROBENZENE) [2]	26-27
A TETRACHLOROBENZENE (1,2,3,5-TETRACHLOROBENZENE) [2] [4]	28
A CHLOROMETHANE {METHYL CHLORIDE} [2]	29-30
A TETRACHLOROBENZENE (1,2,4,5-TETRACHLOROBENZENE)	29-30
A PENTACHLOROBENZENE [2]	31-33
A HEXACHLOROBENZENE [2]	31-33
A BROMOMETHANE {METHYL BROMIDE} [2]	31-33
A TETRACHLORODIBENZO-p-DIOXIN (2,3,7,8-) {TCDD}	34 ✓
CLASS 2	
C TOLUENE {METHYLBENZENE} [2]	35
A TETRACHLOROETHENE [2]	36
A CHLOROANILINE {CHLOROBENZENAMINE}	37
A DDE{1,1-DICHLORO-2,2-BIS(4-CHLOROPHENYLETHYLENE)}	38
C FORMIC ACID {METHANOIC ACID}	39-40
A PHOSGENE {CARBONYL CHLORIDE}	39-40
A TRICHLOROETHENE [2]	41
C DIPHENYLAMINE {N-PHENYLBENZENAMINE}	42-44
A DICHLOROETHENE (1,1-) [2]	42-44
A FLUOROACETIC ACID	42-44
D DIMETHYLBENZ[a]ANTHRACENE (7,12-)	45
B ANILINE {BENZENAMINE}	46-50
C, B FORMALDEHYDE {METHYLENE OXIDE}	46-50
A MALONONITRILE {PROPANEDINITRILE}	46-50
A METHYL CHLOROCARBONATE {CARBONOCHLORIDIC ACID, METHYL ESTER}	46-50

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Code	Principal Hazardous Organic Constituent	Rank
A	METHYL ISOCYANATE {METHYLCARBAMYLAMINE}	46-50
F, B	AMINOBIIPHENYL (4-) {[1,1'-BIPHENYL]-4-AMINE}	51
F, B	NAPHTHYLAMINE (1-)	52-53
F, B	NAPHTHYLAMINE (2-)	52-53
A	DICHLOROETHENE (trans-1,2-) [2]	54
A	FLUOROACETAMIDE (2-)	55-56
F	PROPYN-1-OL (2-) {PROPARGYL ALCOHOL}	55-56
F	PHENYLENEDIAMINE (1,4) {BENZENEDIAMINE}	57-59
F	PHENYLENEDIAMINE (1,2-) {BENZENEDIAMINE}	57-59
C	PHENYLENEDIAMINE (1,3-) {BENZENEDIAMINE}	57-59
F, B	BENZIDINE {[1,1'-BIPHENYL]-4,4'-DIAMINE}	60-64
F, B	ACRYLAMIDE {2-PROPENAMIDE}	60-64
F, D	DIMETHYLPHENETHYLAMINE (alpha, alpha-)	60-64
E	METHYL METHACRYLATE {2-PROPENOIC ACID, 2-METHYL-, METHYL ESTER}	60-64
A	VINYL CHLORIDE {CHLOROETHENE}	60-64
A	DICHLOROMETHANE {METHYLENE CHLORIDE} [2]	65-66
E	METHACRYLONITRILE {2-METHYL-2-PROPENENITRILE} [2]	65-66
A	DICHLOROBENZIDINE (3,3'-)	67
A	METHYLCHOLANTHRENE (3-)	68
F, D	TOLUENEDIAMINE (2,6-) {DIAMINOTOLUENE}	69-77
F, D	TOLUENEDIAMINE (1,4-) {DIAMINOTOLUENE}	69-77
F, B	TOLUENEDIAMINE (2,4-) {DIAMINOTOLUENE}	69-77
F, D	TOLUENEDIAMINE (1,3-) {DIAMINOTOLUENE}	69-77
F, D	TOLUENEDIAMINE (3,5-) {DIAMINOTOLUENE}	69-77
F, D	TOLUENEDIAMINE (3,4-) {DIAMINOTOLUENE}	69-77
A	CHLORO-1,3-BUTADIENE (2-) {CHLOROPRENE}	69-77
A	PRONAMIDE {3,5-DICHLORO-N-{1,1-DIMETHYL-2-PROPYNYL} BENZAMIDE}	69-77
A	ACETYLAMINOFLUORENE (2-) {ACETAMIDE,N-{9H-FLUOREN-2-YL}-}	69-77
<u>CLASS 3</u>		
F, B	DIMETHYLBENZIDINE (3,3'-)	78
F	n-PROPYLAMINE {1-PROPANAMINE}	79
C	PYRIDINE [2]	80
F, D	PICOLINE (2-) {PYRIDINE, 2-METHYL-}	81-84
A	DICHLOROPROPENE (1,1-) [2]	81-84
F, B	THIOACETAMIDE {ETHANETHIOAMIDE}	81-84
A	1,2,2-TRICHLORO-1,1,2-TRIFLUOROETHANE [2] [3]	81-84
F, D	BENZ[c]ACRIDINE {3,4-BENZACRIDINE}	85-88
A	DICHLORODIFLUOROMETHANE [2]	85-88
C	ACETOPHENONE {ETHANONE, 1-PHENYL-} [2]	85-88
A	TRICHLOROFLUOROMETHANE [2]	85-88
A	DICHLOROPROPENE (trans-1,2-)	89-91
A	ETHYL CYANIDE {PROPIONITRILE} [2]	89-91
E	BENZOQUINONE {1,4-CYCLOHEXADIENEDIONE}	89-91
F, D	DIBENZ[a,h]ACRIDINE {1,2,5,6-DIBENZACRIDINE}	92-97
F, D	DIBENZ[a,j]ACRIDINE {1,2,7,8-DIBENZACRIDINE}	92-97
A	HEXACHLOROBUTADIENE (trans-1,3) [2]	92-97
F, D	NAPHTHOQUINONE (1,4-) {1,4-NAPHTHALENEDIONE}	92-97
C	DIMETHYL PHTHALATE [2]	92-97
A	ACETYL CHLORIDE {ETHANOYL CHLORIDE} [2]	92-97
D	ACETONYLBENZYL-4-HYDROXYCOUMARIN (3-alpha-) {WARFARIN}	98-99
C	MALEIC ANHYDRIDE {2,5-FURANDIONE}	98-99

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Code	Principal Hazardous Organic Constituent	Rank
C	PHENOL {HYDROXYBENZENE}	100-101
F, D	DIBENZO[c,g]CARBAZOLE (7H-) {3,4,5,6-DIBENZCARBAZOLE}	100-101
A	CHLOROPHENOL (2-)	102
C	CRESOL (1,3-) {METHYLPHENOL}	103
C	CRESOL (1,4-) {METHYLPHENOL} [2]	104-105
C	CRESOL (1,2-) {METHYLPHENOL}	104-105
E	ACROLEIN {2-PROPENAL}	106-107
F, D	DIHYDROXY-ALPHA-{METHYLAMINO}METHYL BENZYL ALCOHOL (3,4-)	106-107
C	METHYL ETHYL KETONE {2-BUTANONE} [2]	108-109
E, B	DIETHYLSTILBESTEROL	108-109
A	BENZENETHIOL {THIOPHENOL} [2]	110
C	RESORCINOL {1,3-BENZENEDIOL}	111
C	ISOBUTYL ALCOHOL {2-METHYL-1-PROPANOL} [2]	112
C	CROTONALDEHYDE {2-BUTENAL} [2]	113-115
A	DICHLOROPHENOL (2,4-)	113-115
A	DICHLOROPHENOL (2,6-)	113-115
E, D	METHYLACTONITRILE (2-) {PROPANENITRILE, 2-HYDROXY-2-METHYL}	116-118
C	ALLYL ALCOHOL {2-PROPEN-1-OL}	116-118
A	CHLOROCRESOL {4-CHLORO-3-METHYLPHENOL}	116-118
C, D	DIMETHYLPHENOL (2,4-)	119
CLASS 4		
A	CHLOROPROPENE 3-{ALLYL CHLORIDE} [2]	120
A	DICHLOROPROPENE (cis-1,3-)	121-125
A	DICHLOROPROPENE (trans-1,3-)	121-125
A	TETRACHLOROETHANE (1,1,2,2-) [2]	121-125
A	TRICHLOROPHENOL (2,4,5-)	121-125
A	TRICHLOROPHENOL (2,4,6-)	121-125
A	CHLOROETHANE (ETHYL CHLORIDE) [4] [5]	126
A	DICHLOROPROPENE (2,3-)	127-130
F, B	HYDRAZINE (DIAMINE) [5]	127-130
A	BENZYL CHLORIDE {CHLOROMETHYLBENZENE} [2]	127-130
A	DIBROMOMETHANE {METHYLENE BROMIDE} [2]	127-130
A	DICHLOROETHANE (1,2-) [2]	131
A	MUSTARD GAS {bis[2-CHLOROETHYL]-SULFIDE}	132-134
A	NITROGEN MUSTARD	132-134
A	N,N-BIS(2-CHLOROETHYL)2-NAPHTHYLAMINE {CHLORNAPHAZINE}	132-134
A	DICHLOROPROPENE (3,3-)	135
A	DICHLORO-2-BUTENE (1,4-)	136-140
A	TETRACHLOROPHENOL (2,3,4,6-)	136-140
A	TETRACHLOROMETHANE {CARBONTETRACHLORIDE} [2]	136-140
A	BROMOACETONE {1-BROMO-2-PROPANONE}	136-140
A	HEXACHLOROPHENE {2,2'-METHYLENEbis[3,4,6-TRICHLOROPHENOL]}	136-140
F, B	DIOXANE (1,4-) {1,4-DIETHYLENE OXIDE} [2]	141
A	CHLORAMBUCIL	142
C	NITROBENZENE [2]	143
A	CHLOROPROPIONITRILE (3-) {3-CHLOROPROPANENITRILE} [2]	143-144
A	DICHLORO-2-PROPANOL (1,1-)	145-146
A	DDD {DICHLORODIPHENYLDICHLOROETHANE}	145-146
A	DICHLORO-2-PROPANOL (1,3-)	147
C	PHTHALIC ANHYDRIDE {1,2-BENZENEDICARBOXYLIC ACID ANHYDRIDE}	148-150
A	METHYL PARATHION	148-150

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
E, D NITROPHENOL (4-)	148-150
A CHLORODIFLUOROMETHANE [2] [4]	151-153
A PENTACHLOROPHENOL	151-153
A HEXACHLOROCYCLOHEXANE (LINDANE) [2]	151-153
A DICHLOROFLUOROMETHANE [2] [4]	154-157
E DINITROBENZENE (1,3-)	154-157
C NITROANILINE (4-NITROBENZENAMINE)	154-157
R PENTACHLOROETHANE [2]	154-157
E DINITROBENZENE (1,4-)	158-161
C DINITROBENZENE (1,2-)	158-161
A TRICHLOROETHANE (1,1,2-) [2]	158-161
A TRICHLOROMETHANE (CHLOROFORM) [2]	158-161
A DIELDRIN	162-164
A ISODRIN	162-164
A ALDRIN	162-164
R DICHLOROPROPANE (1,3-) [5]	165
D NITROTOLUIDINE (5-) (BENZENAMINE,2-METHYL-5-NITRO-)	166-167
A CHLOROACETALDEHYDE	166-167
A TRICHLOROPROPANE (1,2,3-) [2]	168-173
F, B DINITROTOLUENE (2,4-)	168-173
E DINITROTOLUENE (2,6-)	168-173
A HEXACHLOROCYCLOPENTADIENE	168-173
A BENZAL CHLORIDE (ALPHA, ALPHA-DICHLOROTOLUENE) [2]	168-173
A DICHLORO-1-PROPANOL (2,3-)	168-173
F, B ETHYLENE OXIDE (OXIRANE) [5]	174
A DICHLOROETHANE (1,1-) (ETHYLIDENE DICHLORIDE) [5]	175-178
A DIMETHYLCARBAMOYLCHLORIDE	175-178
C GLYCIDYALDEHYDE (1-PROPANOL-2,3-EPOXY)	175-178
A DDT (DICHLORODIPHENYLTRICHLOROETHANE)	175-178
R DICHLOROPROPANE (1,2-) (PROPYLENE DICHLORIDE) [5]	179
F, B AURAMINE	180-181
A HEPTACHLOR	180-181
R DICHLOROPROPANE (1,1-) [5]	182
A CHLORO-2,3-EPOXYPROPANE (1-) (OXIRANE,2-CHLOROMETHYL-)	183-186
C DINITROPHENOL (2,4-)	183-186
A bis(2-CHLOROETHYL)ETHER [2]	183-186
C TRINITROBENZENE (1,3,5-TRINITROBENZENE)	183-186
S BUTYL-4,6-DINITROPHENOL (2-sec-) (DNBP)	187-188
C CYCLOHEXYL-4,6-DINITROPHENOL (2-)	187-188
A bis(2-CHLOROETHOXY)METHANE	189-192
C CHLORAL (TRICHLOROACETALDEHYDE)	189-192
C TRICHLOROMETHANETHIOL	189-192
C DINITROCRESOL (4,6-) (PHENOL,2,4-DINITRO-6-METHYL-)	189-192
C HEPTACHLOR EPOXIDE	193
C DIEPOXYBUTANE (1,2,3,4-) (2,2'-BIOXIRANE)	194
CLASS 5	
B BENZOTRICHLORIDE (TRICHLOROMETHYLBENZENE)	195-196
C METHAPYRILENE	195-196
C PHENACETIN (N-[4-ETHOXYPHENYL]ACETAMIDE)	197-198
C METHYL HYDRAZINE [5]	197-198
C DIBROMOETHANE (1,2-) (ETHYLENE DIBROMIDE)	199

Source List

1. NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1990.
2. Dangerous Properties of Industrial Materials, Seventh Edition, N. Irving Sax and Richard J. Lewis, Sr., 1989.
3. Extremely Hazardous Substances, Superfund Chemical Profiles, U.S. EPA, 1988.
4. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 2nd Edition, Marshall Sittig, 1985.
5. Guidance on Setting Permit Conditions and Reporting Trial Burn Results, Volume II of the Hazardous Waste Incineration Guidance Series, EPA/625/6-89/019, January 1989.
6. Guidance Manual for Hazardous Waste Incinerator Permits, Mitre Corporation, PB84-100577, U.S. Department of Commerce, National Technical Information Service, July 1983.
7. Buyers Guide, chemicalweek 1992.

ATTACHMENT 2

**ANALYTICAL RESULTS (USING THE FIELD SCREENING METHOD)
OF RANDOM SAMPLING AND ANALYSIS PERFORMED OF THE
SOIL SEGREGATED ON THE UPPER LAGOONS FOR USE
DURING THE TRIAL BURN**

ON-SITE
SAVANNA ARMY DEPOT ACTIVITY
SAVANNA, (IL)MOIS

UPPER LAGOON SAMPLING
TRIAL BURN SOIL

DATE:
Data File Name:
Response Factor:
TIME:

10-MAY-92
UL070102
0.0219
14:19

REF	CLIN ID	MEDIA	INT ABS BEFORE REAGENTS (ABS UNITS)	D.F.	INT ABS AFTER REAGENTS (ABS UNITS)	INT CONC (UG/G)	INT CONC percent	SPIKE REC (%)
1	UL-1	SOIL	0.12	10.00	1.02	401.20	0.04%	
2	UL-2	SOIL	0.07	10.00	2.42	950.07	0.10%	
3	UL-3	SOIL	0.04	100.00	0.24	972.61	0.09%	
4	UL-4	SOIL	1.34	100.00	0.14	467.07	0.05%	
5	UL-5	SOIL	0.24	10.00	0.90	375.34	0.04%	
6	UL-6	SOIL	0.11	10.00	0.84	326.00	0.03%	
7	UL-7	SOIL	0.07	10.00	1.74	494.70	0.07%	
8	UL-8	SOIL	0.34	10.00	2.93	1147.71	0.11%	
9	UL-9	SOIL	0.44	10.00	2.11	890.64	0.08%	
10	UL-10	SOIL	0.05	10.00	0.54	212.61	0.02%	
11	UL-11	SOIL	0.06	10.00	0.94	370.84	0.04%	
12	UL-12	SOIL	0.05	10.00	1.59	632.77	0.06%	
13	UL-BLAME	SOIL	0.00	1.00	0.01	0.16	0.00%	
14	UL-B.S.	SOIL	0.00	1.00	0.04	2.05	0.00%	102%
						AVERAGE		
						405.85		

Samples were collected from the Southeast corner
of the Upper lagoon

ACTION LEVEL NON-EMERGENTIC IS 100,000 (ug/g) ppm or 10 percent.

ACTION LEVEL FOR CLEAN-UP ACTIVITIES IS 21.5 (ug/g) or ppm

CALCULATION:

$(INT\ AFTER \times DILUTION\ FACTOR) - (2 \times INT\ BEFORE)$
RESPONSE FACTOR

Soil samples were collected randomly from soil stockpiled for the Trial Burn.

ATTACHMENT 3
HAZARDOUS WASTE COMPATIBILITY CHART

HAZA

[illegible]



**The Earth Technology
Corporation**

HAZARDOUS WASTE COMPATIBILITY CHART

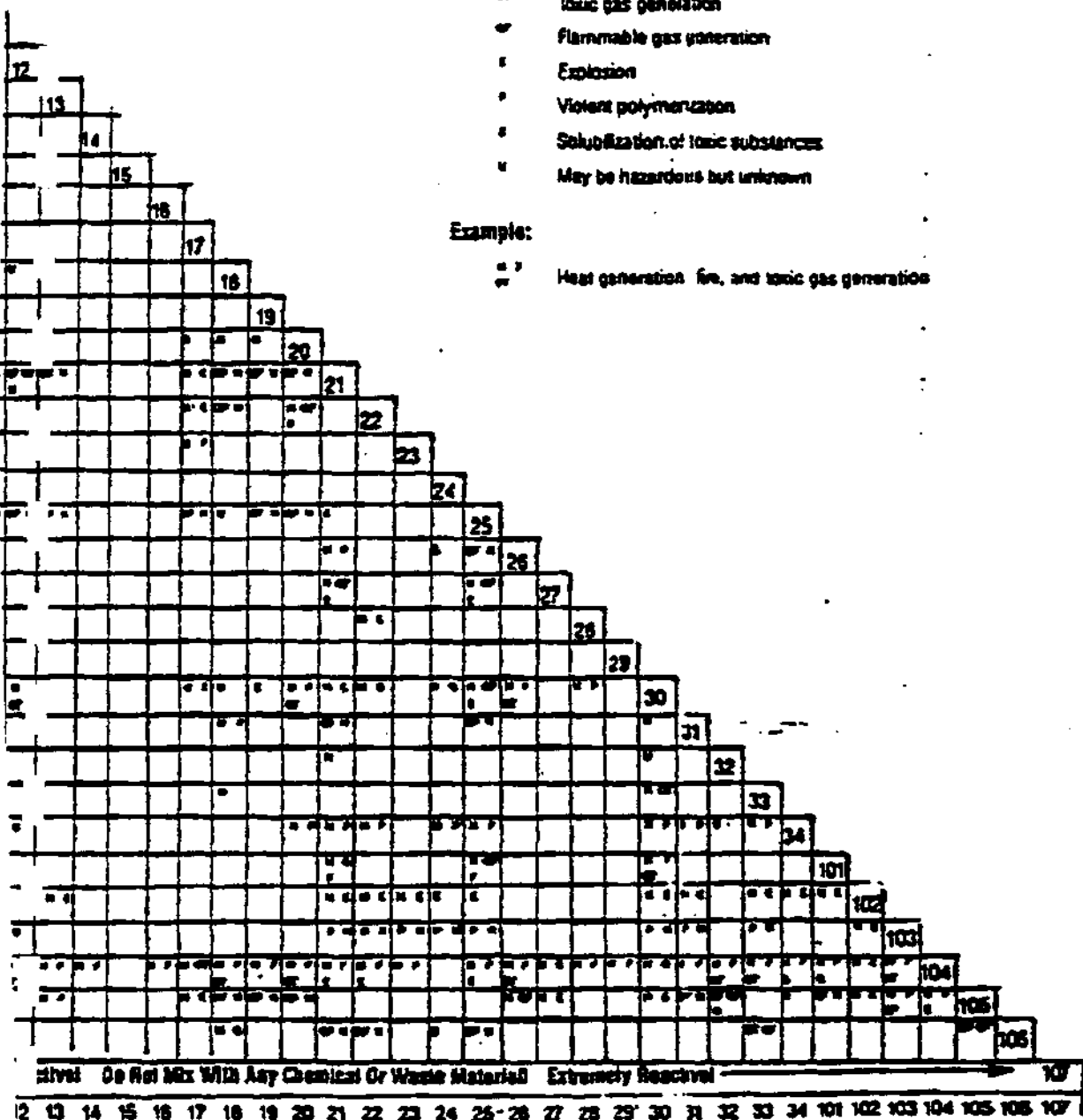
Reactivity Code

Consequences:

- Heat generation
- Fire
- Innocuous and non-flammable gas generation
- Toxic gas generation
- Flammable gas generation
- Explosion
- Violent polymerization
- Solubilization of toxic substances
- May be hazardous but unknown

Example:

- • Heat generation, fire, and toxic gas generation



COM-38

ATTACHMENT 4
HAZARDOUS COMPONENT SAFETY DATA SHEET

HAZARDOUS COMPONENT SAFETY DATA SHEET (ARRADCOM Suppl 1 to DARCOMR 385.17)		Date 17 Jun 83
Material/Component/Assembly TNT (Trinitrotoluene)		Number 33
Applicable DAR Safety Clause 7-104.79		Revision 0
SENSITIVITY		
Friction Test (Apparatus & Comparison Values)		PA Steel/Fiber - Unaffected
Impact Test (Apparatus & Comparison Values)		PA 14 Inches
Electrostatic Discharge Test (Apparatus & Comparison Values)		See Attached Sheet
HAZARDS		
Fire Moderate		
Auto Ignition Temp 240°C (464°F)		Flash Point NA
Decomposition Products Toxic, Avoid Ingestion and Inhalation		
Flammable Limits NA	Lower Percent	Upper Percent
Explosion High		
Explosive Temp (5 sec) Decomposes 475°C (887°F)		Dusts See Attached Sheet
Toxicity Highly toxic when inhaled or ingested.		
In-Process Hazards Classification Class 1.1		
Special Requirements (Continuation Sheets Authorized) Ref Spec: MIL-T-248 Approved packaging drawings - 7548644, 7548645 and 9257923.* 8 hour time weight average (Skin) 0.5 mg/m ³ 15 minute short term exposure limit - (Skin) 8 mg/m ³ UN Ident - 0209 UN Hazard Class - 1.1D NSN 1376-00-628-3333 1376-00-672-0265 1376-01-047-0660		
• SHIPPING/STORAGE CLASSIFICATION OF ITEM WHEN PACKED IN ACCORDANCE WITH APPROVED PACKING DRAWINGS		
DOD Hazard Class 1.1		DOD Compatibility Group 0
DOT Hazard Class Class A Explosive		DOT Container Marking High Explosive - Dangerous
Prepared by R. Batson <i>R. Batson</i>		
Concurred R. W. Snook <i>R.W. Snook</i>		
Safety Office E. Demberg <i>E. Demberg</i>		

33
D
17 Jun 83

TNT

1. TNT is a powerful explosive, sensitive to strong shock and high temperatures. The hazard to explosion is increased with higher temperatures or increased confinement. Cast TNT is more sensitive to shock than the pressed form. TNT is one of the most stable of the high explosives. It starts gaseous decomposition at 160°C.
2. TNT has a flammability index of 100. Small amounts of TNT will burn if not confined. Combustion of large quantities may proceed vigorously or even cause detonation.
3. (To prevent skin and eye contact,) inhalation and ingestion, personal protective clothing and eye protection should be provided. Personal cleanliness should be enforced. Indicator soaps are valuable to insure complete removal of TNT from skin. TNT operations that are dusty or in a confined area should have a ventilation system and/or respirators depending on the length of exposure and amount of dust or fumes generated.
4. Present NATO specification - STANAG 4025 "Specification for TNT (Tolite) for Deliveries from one NATO Nation to Another" in draft status as of 8/82.
5. CAUTION: EXPLOSIVES MUST BE TESTED FOR COMPATIBILITY WITH ANY MATERIAL NOT SPECIFIED IN THE PRODUCTION-PROCUREMENT PACKAGE WITH WHICH THEY MAY COME IN CONTACT. MATERIALS INCLUDE OTHER EXPLOSIVES, SOLVENTS, ADHESIVES, METALS, PLASTICS, PAINTS, CLEANING COMPOUNDS, FLOOR AND TABLE COVERINGS, PACKING MATERIALS AND OTHER SIMILAR MATERIALS. SITUATIONS AND EQUIPMENT, EXPLOSIVES INCLUDE PROPELLANTS AND PYROTECHNICS.
6. HAZARD CLASSIFICATION TESTS (TB700-2) (Ref-SMUPA-V (Temp) 2019 Jun 70)
 - a. Detonation Test - samples exploded (mushrooming 0.868 inches)
 - b. Ignition and Unconfined Burning Test - No explosions, samples burned. Average burning time - greater than 120 seconds.
 - c. Thermal Stability Test - No explosions, ignition or change in configuration.
 - d. Card Gap Test - 162 cards (Produced hole in plate).
 - e. Impact Sensitivity Test - No explosions, flame or noise in 10 trials each at 3 3/4 and 10 inches.
7. Impact Sensitivity Test (TB700-2)

<u>Height, in</u>	<u>Sample Weight, mg</u>	<u>NO OF TRIALS EXHIBITING</u>		
		<u>Explosion.</u>	<u>Decomposition</u>	<u>No Reaction</u>
3 3/4	20	0	0	10
	30	0	0	10
	40	0	0	10
	50	0	0	10

Sheet 2 of 5

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 0
 17 Jun 83
NO OF TRIALS EXHIBITING

<u>Heighting</u>	<u>Sample Weight, mg</u>	<u>Explosion</u>	<u>Decomposition</u>	<u>No Reaction</u>
7	20	0	0	10
	30	0	0	10
	40	0	0	10
	50	0	0	10
10	20	0	0	10
	30	0	0	10
	40	0	0	10
	50	0	0	10
15	20	0	0	10
	30	0	0	10
	40	0	0	10
	50	0	0	10

8. Impact Sensitivity

a. Bureau of Mines - 95-100 + cm.

b. H₅₀ Bare Tool using 2 kg weight

20 kg Sample (No Vacuum) - 102 cm (Multiple Crystal)

20 kg Sample (No Vacuum) - 53 cm (Single Crystal)

c. H ₅₀ (m)	<u>12 Tool</u>	<u>12B Tool</u>
5 kg	0.80	>1.77
2.5 kg	1.48	~1.00

d. Sensitivity Versus Temperature
PA Apparatus, 2 kg Weight

<u>°C (°F)</u>	<u>Inches</u>
-40 (-40)	17
Room	14
80 (176)	7
90 (194)	3
105-110 (221-230)	2 (5 Explosions/20 Trials)

9. Electrostatic Sensitivity

a. Through 100 mesh

Sheet 3 of 5

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D
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Unconfined 0.06 Joules
Confined 4.4 Joules

b. Bureau of Mines - 0.062 Joules

c. Through 100 Mesh

Unconfined 0.062 Joules
Confined 4.38 Joules

d. As Received

Unconfined > 11.0 Joules
Confined 4.88 Joules

10. Explosion Temperatures

Seconds	°C (°F)
1	520 (968)
10	465 (869)

11. Dust Explosibility (Air)/Thin Layer Propagation

(Ref- Radford AAP, Prod. Engr. Proj. PE-489, Sept. 1976)

Material	Physical Condition	Particle Size, μ	DUST EXPLOSIBILITY (AIR)	
			Min Conf g/m ³	Min Energy, Joules
TNT	Dry	< 840	70	0.075
HMX	Fines, Dry	< 53	470	0.02
HMX	Fines, Dry	-	> 810	> 5.0

12. Gap Sensitivity

(Ref - NOLTR 65-177)

Material	Density, g/cc	GAP SENSITIVITY, 50% POINT	
		Cards	Press, K bar
TNT	1.60	183	21
	1.49	208	16
Tetryl	1.62	261	10
	1.49	283	9
RDX	1.64	284	9
	1.53	336	7

13. Susan Test*

Threshold velocity ~236 ft/sec (~72 m/s); very difficult to ignite accidentally, and has very low probability of buildup to violent reaction.

Sheet 4 of 5

14. Detonation Rate (Density 1.56 gm/cc)
Pressed - 6825 meters/second
Cast - 6640 meters/second

15. Conveyor Spacing Test

A 38-mm (1.5-in) depth of bulk TNT explosive on a 0.61-metre (24-inch) wide commercially available Serpentix (corrugated) rubber belt conveyor with a separation of 25 mm (1.0 in) between conveyor troughs, will prevent propagation of a high-order explosion along the entire conveyor system.

Ref - ARRADCOM
Large Caliber Weapon Systems Laboratory
Dover, NJ 07801
Technical Report ARLCD-TR-78003

16. Skid Test

Impact angle (deg (rad)) - 14 (0.24)

Drop, HT (ft (m)) - 10.0 (3.05)

Event - 2

17. Gap Test

a. Small Scale (mils (mm))

8-16 (0.20 - 0.41) - Lawrence Livermor Rpt UCRL - 51319
(3.96) - NMSC
(0.33) - LANL

b. Large Scale (mils (mm))

1.944 (49.4) - LANL

18. Sensitivity (Comparison Values)

a. Impact, PA Apparatus

Explosive

Lead Azide
RDX
Black Powder

Inches

4-6
8
16 (10% Point)

b. Electrostatic Discharge, Bureau of Mines apparatus

Explosive

Lead Azide
RDX
Black Powder

Joules

0.007
> 11.03
Confined 0.8/unconfined > 12.5

Sheet 5 of 8

TOTAL P.21